GEOLOGY AND COALS OF WEBSTER COUNTY

LEONIDAS CHALMERS GLENN

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The

Kentucky Geological Survey

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

SERIES SIX
VOLUME FIVE

Geology and Coals of Webster County

1922

POWER HOUSE AND TIPPLE, PROVIDENCE COAL AND MINING CO.

This coal mine, located near Providence, Ky., is representative of the large group of systematically organized mining operations of Webster County. No. 9 coal is operated at a shaft depth of 105 feet. The mine has a capacity of 800 tons per day and is served by the L. & N. R. R. The view is northwest and typical of the topography of this region.

The GEOLOGY *and* COALS *of* WEBSTER COUNTY

An Economic Consideration of the Coals, the Structure and Stratigraphy of this Region, to which is added a Detailed Geological Map of Webster County

BY

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Letter of Transmission

Dr. W. R. Jillson,
Director and State Geologist
The Kentucky Geological Survey,
Frankfort, Ky.

My Dear Sir:—

I beg to transmit herewith the manuscript of a report on the Geology and Coals of Webster County, Kentucky, together with a detailed geological map of the county and various sections and photographic illustrations.

Very respectfully yours,
L. C. Glenn.

Department of Geology
Vanderbilt University
Nashville, Tenn

65309

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The Geology and Coals *of* Webster County

The Geology *and* Coals *of* Webster County, Kentucky

CHAPTER I.

INTRODUCTION

Preparation of Report. In 1909 the writer was employed by Prof. C. J. Norwood, then State Geologist of Kentucky, to make a detailed study of a portion of the little known Western Kentucky Coal Field for the State Geological Survey. Field work was conducted during the summers of 1909, 1910 and 1911. In order to gain an acquaintance with the broader general features of the stratigraphy and structure, a general reconnoissance was first made of parts of Union, Webster, Hopkins, Crittenden, Caldwell and Christian counties. This study occupied the summer of 1909 and the results were submitted for publication early in 1910. This report was published in 1912 as Bulletin 17 of the third Kentucky Geological Survey under the title, "A Geological Reconnoissance of the Tradewater River Region, with Special Reference to the Coal Beds."

This reconnoissance was followed by a detailed study of the geology of Webster county in 1910 and 1911. Webster county was selected for detailed study because of a number of reasons. Activity both in mining and prospecting for coal was then very great so that the local interest was strong. The county is situated in practically the center of the basin so that a detailed study of it would be of much value in throwing light on the geology of a number of counties around it. The reconnoissance made it practically certain that the deepest part of the entire western interior coal basin lay within Webster county and that it would consequently furnish the longest and most useful stratigraphic column of the coal measures for general study and correlation. The county, furthermore, is crossed from east to west by the profound disturbance known as the Rough Creek fault,[1] a feature

[1] Occasionally called the Gold Hill disturbance.

that not only is of much scientific interest but also is of much practical importance in its relationship to the distribution and depth of the coals and the possible occurrence of oil.

A detailed report on the geology of Webster county was placed in Prof. Norwood's hands shortly before he retired from office as State Geologist. The manuscript of this report was transmitted by him on July 1st, 1912, to his successor in office, Mr. J. B. Hoeing. Immediate publication was, however, prevented by an opinion given by the Attorney General of the State that the reports of the Norwood Survey could not be published as such by the Hoeing Survey. In the opinion it was suggested, however, that they might be published by being adopted by the Hoeing Survey and incorporated into its reports as a part of them.[2]

When, after some time, it appeared unlikely that the Webster county report would ever be published by the State, the U. S. Geological Survey sought permission to publish it as one of its series of bulletins. This offer, however, was declined by the State Survey and so the matter rested for a time. The writer later again raised the question of publication with the Kentucky Survey and arrangements were finally made with Mr. Hoeing to make some revision of the report and publish it.

This plan was, however, prevented by the war and when after its close and after Dr. Jillson had become State Geologist the matter was once more taken up by the writer, it was found that the entire manuscript transmitted to the Hoeing Survey in 1912 had disappeared. Dr. Jillson arranged with the writer to prepare a new report on Webster county. The present report has been written in part from a portion of the author's first draft of 1912; in part it is an entire rearrangement of the 1912 draft; and in part it is entirely new. Before beginning the present report the writer again spent some weeks in the field in order to bring the material on which it is based up to date. After such a long and checkered history the report at last bids fair to see the light of day. The geologic map will appear separately later.

Acknowledgments. Mining men supplied freely all information the writer asked for while in the field and assisted the work in many ways. To make proper acknowledgment would

[2] Ky. Geol. Surv., Ser. 4, Vol. 1, Pt. 1, pp. 13, 14; 1913.

be to mention them all and make a list too long for insertion here. Although at the risk of making an invidious distinction, the writer cannot refrain from acknowledging his especially great indebtedness to the West Kentucky Coal Company. This company freely placed their wealth of engineering data at the writer's disposal and took no little trouble to furnish levels, locations, logs and special maps of mines and properties whenever asked for, and have contributed illustrative material freely. The Clifty Consolidated Company furnished much information as to bore holes about Clay and a photograph of their mine. The Ruckman, the Providence, the Economy and the St. Bernard companies gave much information for the region about Providence.

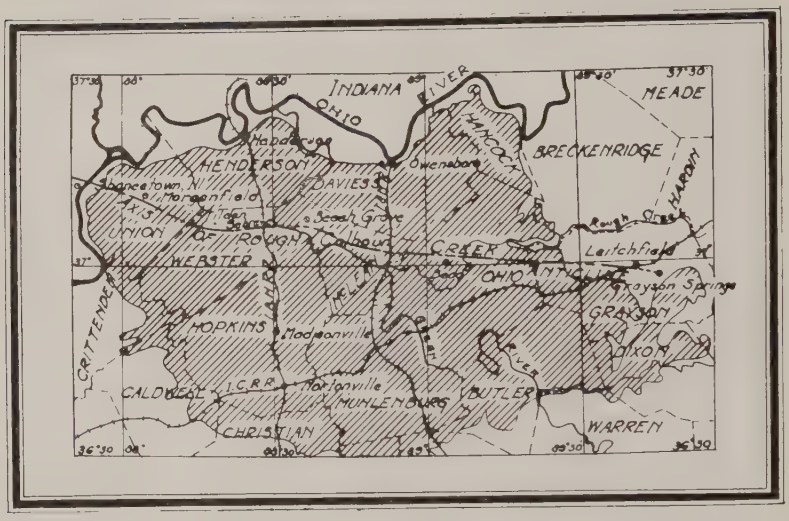
Situation and Boundaries.

Webster county is situated in the western part of the state near the northern, or Ohio river, boundary, from which it is separated by only one tier of counties. In spite of the broken or angular course of its nothwestern boundary, the shape of the county may be described as being roughly quadrangular with its greatest length made from southwest to northeast.

It extends from Tradewater river, which forms its southwestern boundary, northeast to Green river, which forms its northeastern boundary. Its southeastern and northwestern boundaries are artificial lines. On the southeast it is bounded by Hopkins county and on the northwest by Union and Henderson. It is in the western part of the West Kentucky coal field. Its area is given by the U. S. census of 1920 as 344 square miles and its population as 20,762, or 60.4 per square mile, making it one of the more thickly populated counties of the state. Its position in the western coal field and its general geographic setting and some of its structural relationships are shown in Plate 1.

Towns.

Dixon is the county seat. It is situated on the Dixon upland in almost the center of the county. It is connected by a branch line of the Illinois Central railroad with Clay, Wheatcroft, Providence and Blackford. Its importance is due to its being the county seat. There is no mining because it is in the heart of a great structural basin or syncline and the important coal seams that are mined elsewhere in the county are there one thou-



NO. 1. SKETCH MAP OF WESTERN KENTUCKY COAL FIELD.

sand feet or more beneath the surface. A few local openings have been made near Dixon on thin coals that lie high in the series but they are of very minor importance. Occasionally these high thin coals have erroneously been taken to be number 9 or number 11 coal.

Providence in the southwestern corner of the county on the Illinois Central and Louisville and Nashville railroads, is the largest town in the county. It is situated on the outcrop of number 9 and number 11 coals and derives its importance from its numerous coal mines.

Clay and Wheateroft are also mining towns in the western part of the county located on or near the outcrops of numbers 9, 11, and 14 coals. Clay is reached by the Louisville and Nashville railroad and both Clay and Wheateroft have the Illinois Central.

Sebree, in the notheastern part of the county on the Louisville and Nashville railroad, mines number 9 coal on the north side of the great Rough Creek fault, which runs thru the town. It also mills grain and is a general trading center for a good farming country.

There are a good number of smaller towns and villages such as Blackford, Hearin, Lisman, Tilden, Poole, Marksville, Van-

derburg, Belcourt, Slaughtersville, Onton and others that are local trading centers. Those on the railroads have usually been of recent origin, while those away from the railroads are old and well settled communities.

Occupations.

Agriculture and coal mining are the two chief occupations and rank in importance in the order named. Lumbering has been important in the past but most of the timber has now been cut. Agriculture being more universally pursued, is of greatest importance. Of recent years further impetus has been given to agriculture by the drainage of much of the swampy lowlands, as will be described on page 13. Tobacco, corn, wheat, oats and

NO. 2. EROSION OF LOAM ON UPLAND SLOPE.

Unless cared for properly the loess, or loam, on cleared hill sides erodes rapidly and soon destroys the entire value of the land.

fruits are the chief crops. Some truck is grown either for the local market in the mining towns or for canneries. Hogs and cattle are also raised. The loess-like loam which covers much of the uplands is easily tilled and when carefully built up may be brought to a high state of cultivation. If neglected, it may gully and wash so badly as to become practically worthless, as may be seen in Plate No. 2. The lowlands when properly drained make excellent crops.

Coal mining has long been an important occupation and in the last twenty years it has developed especially fast. Most of this development has centered about Wheatcroft, Clay and Providence along the outcrop of the more important seams, numbers 9, 11, and 14, as they cross the southwestern part of the county. One of the noteworthy features of this mining development is the finding in the region just north of Clay of a thick coal of most excellent quality in such position above number 12 coal that it has been called number 14 coal. It is also called here the Baker coal. This coal is extensively mined by the West Kentucky Coal Company at their Baker and their number 7 mines near Clay. The latter is the largest, most modern, and best equipped mine in the county. The Ohio river tipple is shown in plate No. 3.

NO. 3. OHIO RIVER TIPPLE, WEST KENTUCKY COAL CO.
This is a modern steel and concrete tipple for loading coal on river barges.

Future Development of Coal Mining. Almost the enti county is underlaid by workable coal as will be set forth in detail in the succeeding pages of this report. A belt along the southwestern edge of the county bordering the Tradewater river and less than two miles in average width, is underlaid by only the lower coals or those at the base of the measures. These do not outcrop in the county and have not been tested by borings so that it is not certain whether any of them are thick enough to mine here under the present conditions. The rocks in this part

of the county dip to the northeast into the center of the basin whose deepest part is situated in the Dixon region. These lower coals consequently pass under all of the later coals and underlie practically the entire county.

Northeast of this first belt, underlaid by only the lowest coals, there is a parallel belt some two miles in width in which Owen's coal number 5, now usually called number 6, is present and of workable thickness. It dips to the northeast and soon passes under coals 9 to 11. The outcrop of these latter run in nearly parallel lines from near Wheatcroft to Providence and they likewise dip northeastward into the Webster syncline. In addition to these coals of widespread occurrence, there is, as mentioned above, a coal here called number 14 or the Baker coal, that is at least locally developed in the region north and northeast of Clay, but whose entire extent is unknown.

Coal number 9 and all others below it are very regular in occurrence and underlie practically all of the county to the northeast of the outcrops given above in the Wheatcroft-Providence region except along a narrow faulted belt crossing the northern part of the county east and west thru Tilden and Sebree and known as the Rough Creek fault. The higher coals, numbers 11 and 14, are less regular in occurrence but underlie a large but undertermined part of the county.

Any of these coals are accessible at present at moderate depths in a broad belt across the southwestern end of the county and in the area across the northern end of the county north of the Rough Creek fault.

With almost the entire area of the county underlaid by coals, some of which are remarkably persistent and uniform, it may be seen that there are possibilities of very great additional development of coal mining under present economic conditions and as in future years conditions slowly change so as to permit deeper shafting, it will gradually become practicable to mine the coals in even the deepest part of the Webster basin.

Transportation.

The Illinois Central and Louisville and Nashville railroads reach all parts of the county where commercial mining operations are now active. In addition the West Kentucky Coal Com-

pany carry their own coal from their mines at Wheatcroft and Baker and near Clay down to their tipple on the Ohio river just above the mouth of the Tradewater. From there it is carried by their fleet of barges to New Orleans and other points down the river. See plate No. 4. Along the eastern edge of the

NO. 4. A TOW OF COAL BARGES.

Barges are here assembled by the West Kentucky Coal Co. for shipment to New Orleans and other places down the Ohio and Mississippi rivers.

county transportation for produce is furnished by boats on Green river. Boats no longer ply the Tradewater, though a drawbridge is still maintained at the railroad crossing at Blackford. The Green is always deep enough for boats to run, but the Tradewater in late summer goes almost dry.

The county thus has ample facilities for the transport of all of the coal that may be mined. That which is carried down the Ohio and Mississippi in barges has an advantage over Pittsburg coals in the much shorter haul and in having sufficient depth of water for barging practically the year round. That which is shipped by rail supplies the adjacent parts of Kentucky and is carried south into Tennessee and Northern Mississippi where Nashville, Memphis and many other smaller cities are partly or entirely supplied. In Nashville it competes successfully with Tennessee coals and in Mississippi it reaches a zone of free competition with Alabama coals. In Louisville and other Kentucky cities it meets in competition the coals from East Kentucky. Across the Ohio it comes into competition with the coals of Indiana and Illinois, which, however, are not usually as good in quality as these Webster county coals.

Roads. While railways and rivers are of prime importance as the major elements in the transportation system that links the county with the outside world, yet the highways are of first importance for local transportation.

In the uplands the roads are apt to follow property lines regardless of the topography and hence are often poorly located. They are in places a succession of steep grades, many of which could be avoided or greatly reduced by a reasonable detour. These steep roads usually wash badly. In the lowlands the roads were formerly the poorest in the county because of the long stretches of undrained swamps. In places such stretches still remain, but most of the lowland roads are now ditched and embanked and are usually the best in the county. The main

NO. 5. LAKE AT SHAMROCK MINE.

The St. Bernard Coal Co. have here provided against the possibility of a failure of water supply in dry seasons.

roads have usually been graded and are generally kept rounded up with scrapers. Very few of the roads have been macadamized or otherwise permanently improved for any distance. During bad weather, especially in winter, even the best of the roads become so badly cut up in places as to be almost impassable.

CLIMATE.

There are no weather bureau stations in the county, but from the records of the station at Earlington, only a few miles to the southeast and at about the same general elevation as this

county, it may be said that the average annual temperature is about 57 or 58 degrees Fahreheit. In summer the temperature often reaches 90 and for a few days may rise to 100 degrees or slightly higher. In winter much of the time the temperature is above freezing and only rarely does it drop to zero or below. Periods of either extreme heat or extreme cold last but a few days at a time. Snow falls occasionally in winter, but never gets deep or lies long. The average annual precipitation is between 45 and 46 inches. It is fairly evenly distributed throughout the year, though there is some excess in the winter and same deficiency in the fall.

At times soft water for boiler purposes is hard to get and at some mines lakes have been built to provide a suitable supply.

CHAPTER II.

TOPOGRAPHY

General Topographic Position. Webster county extends from Tradewater river northeastward to Green river. Its surface consequently comprises the lowlands along these two streams and the intervening uplands or divide between them. These rivers flow northwestward and the divide between them crosses the middle of the county from northwest to southwest in such fashion that slightly more than half of the county slopes southwestward toward Tradewater river. The rest of the county slopes northeastward toward Green river, except for a small area on the northern side of the county that drains northwestward directly to the Ohio through Highland Creek. Since both Green and Tradewater rivers enter the Ohio, the drainage of the entire county is ultimately to that stream.

Drainage.

The drainage of the county is simple in its main outlines but is complex in some of its details. The plan of the drainage is easily grasped by remembering that the southwestern boundary is formed by Tradewater river and the northeastern by Green river, that both flow to the northwest and that side streams from these two rivers have gradually eaten into the intervening country, branching and prolonging themselves until they now occupy and drain all of the interfluvial area. The headwaters of these numerous tributaries of the two rivers now meet in opposing fashion along a narrow divide which crosses the country from northwest to southeast. This divide is practically parallel to the two rivers but is much nearer the Green than the Tradewater. The Tradewater, although much smaller than the Green, empties into the Ohio considerably farther down stream than does the Green and has probably always flowed at a lower level than the Green so that its tributaries have developed on a steeper gradient and have pushed their headwaters somewhat farther back into the intervening uplands than have those of the Green.

Former Ponding of Drainage.

The most striking feature of the present drainage systems of both rivers is that the streams are not generally flowing on bed rock but on an alluvial fill that is 50 to 100 or possibly 200 feet thick. This is amply demonstrated by bore holes and water wells that enter or go through this fill in various places and is described in detail on pages 33 to 34. When the pond filling had been completed the rivers and their tributaries took courses across the flat surface of the pond material in general harmony with their former courses but without being able to follow closely in many places the exact course they had occupied in cutting down their channels before the ponding and valley filling began.

Tradewater river flows today in a very tortuous or irregularly meandering course. Its present channel is probably a half mile to a mile away from its old channel, before the ponding, at such places as Jericho ford, above Montezuma ford and at Wagon ford. At other places, however, such as at two miles above Blackford it is even now hemmed within a narrow gorge. When this gorge was cut 150 or possibly 200 feet deeper, it must have been almost a canyon in appearance. The writer examined the upper, narrower half of this gorge but did not there find rock in place across the river bed. It is believed that this gorge is not of recent cutting but that the river has always passed through it.

The general course of the Tradewater is along the strike of a series of beds that are dipping at a low angle to the northeast. Some of these beds are moderately hard sandstones and others are softer shales. The irregular course of the river valley when taken in detail from the Hopkins county line down to Horseshoe Bend is due to its being held up so that it was slowly cut in soft rocks and was permitted to meander irregularly while just below there it was slowly sawing a gorge down through harder rocks in which it has become entrenched and has thus maintained the antecedent direct course that it has below Horseshoe Bend.

The only tributary of Tradewater of any great consequence today in the county is Craborchard Creek. Its lower course is fairly direct in the main but its channel is very tortuous in detail. Its irregular meanders are due to the flatness of the sur-

face of the deep pond filling on which it flows. All of its numerous headwater branches flow upon similarly flat surfaces and either exhibit similar irregular meanders or lose themselves in marshy ponded areas. A number of these tributaries have been straightened and the marshy areas reclaimed by an extensive system of drainage ditches that have been constructed in the last decade.

Craborchard creek receives the drainage of almost half of the county. Its most important tributary is Caney Fork which heads far back in the Dixon uplands near the Union county line and receives important branches from across the line in Union county, the largest of which is Pond Fork which will be discussed further on page 15. Southeast of Clay the main upper portion of the Craborchard basin is occupied by a swampy area six miles in length and a half mile to a mile in width, known as Slover creek. Into this marshy area, from the Dixon upland, flow Lynn Fork, Slover creek and Bull creek.

Aside from Craborchard creek, the remaining tributaries of Tradewater in Webster county are small and unimportant. The largest of them are Whiteside creek and Owens creek, both of which are small, short streams in the southern part of the county west of Providence.

Adjustment of Drainage.

Changes in the Tradewater Drainage. From a study of the stream alignment in the Tradewater drainage portion of the county in its relation to the structure of the rocks and to the outcrops of hard and soft beds, it becomes evident that extensive changes have occurred in the arrangement of the drainage. There is no evidence that Tradewater river itself has ever materially shifted its position. It has never flowed, for example, through the lowland north of Providence, Clay and Wheatcroft even though this lowland is much wider and may look older than the river's own valley. The width and apparent age are due to the softness of the rocks.

The first tributaries that developed from Tradewater river and stretched by headward growth back into southwestern Webster county seem to have been three in number. They grew approximately at right angles to the river and entered it separ-

ately. When fully developed the upper one of these headed in the region from Dixon southeastward to the Hopkins county line and flowed southwestward through what is now Providence and entered Tradewater where Belleville is now situated. Its lower course is known today as Owen's creek. Its former valley at Providence is marked by a groove that passes east through the southern part of the town and is occupied by the Louisville and Nashville railroad. Its northeastward continuation is marked by a deep notch in the upland just east of the city cemetery. A spur track has been built through it to reach the Webster County Coal Co's. mine. It is possible that a branch may have once extended southeast from where Providence now is along the lowland now occupied by the Louisville and Nashville railroad and have received from Hopkins county the drainage of Rose creek.

The middle tributary headed in the region northwest of Dixon. Its headwater portion is now represented by Lynn Fork. This fork formerly continued its course southwestward and entered the river either a half mile or a mile and a half below where Montezuma ford is now located. A small unnamed stream enters the Tradewater today at each of these two places and from the topography it is not possible to decide definitely which was the former lower course of Lynn Fork.

The third or lower tributary headed northwest of Waggoner Church and Shelton, drained a part of Union county north of Yuba, but did not receive the Pond Fork drainage originally. It flowed along the course of the present Caney Fork and lower Craborchard creek and may have entered the river either where Craborchard today does or slightly lower where Blackford now is.

These three tributaries long flowed in the positions indicated but in cutting down from the old upland level on which they first developed they each encountered hard sandstone beds in their lower courses across the upland which now stretches from Providence to Wheatcroft. For a time each sawed its way down across these sandstones. Finally Craborchard creek sank its channel to a lower level than the others, either because it was larger, or the rocks in its way were somewhat softer, or because it entered the river just below where the river was itself engaged

in sawing a gorge and was unable to lower its own course above there as fast as below there. A branch of Craborchard worked eastward and first captured the upper part of the middle tributary at the point where Lynn Fork now turns west at the west end of Slover swamp. It then pushed farther eastward along the outcrop belt of the soft Lisman shales and soon captured the headwaters of Owens creek.

Another branch of the original Caney Fork-Craborchard, now known as Pond Fork, developed northwest along the same belt of soft shales and captured first Ramsey creek and then Dyson creek in Union county.

These captures were effected before the old buried valleys were eaten out because the abandoned portions of the beheaded streams now show rock in place at present surface level. If Rose creek ever flowed westward to Providence, as seems likely, it was unable to maintain its course after the headwaters of Owen's creek had been captured by Craborchard and was captured by Clear creek.

These drainage changes force flood waters from a large area to gather into one stream and account for the frequent floods on Craborchard Creek that accompany heavy rains. On the other hand the abandoned channels have been of service to man in furnishing easy passages, as at Providence, across upland ridges.

Ohio Drainage. The headwaters of Highland creek extend a few miles into the northern edge of the county and drain a small area directly to the Ohio. Its basin is wedged partly between the Tradewater and the Green river watersheds.

Green River Drainage.

Green river is a much larger stream than Tradewater and flows with a much more direct course, although it is also flowing in a deeply filled valley on a very flat surface. Green river has a narrow channel with steep banks and is unusually deep for a stream of its size. It is navigable the year round but the amount of traffic is small. The valley of Green river along the northeast end of the county is cut through soft shales for the most part. The Sebree hills end in a plunging anticline just south of Steamport Ferry and the shales to the northeast and southeast of it

along the course of the river belong to the Carbondale and the Lisman formations. It is probable that there has also been some faulting along its course as the rocks at Wrightsburg and in the hills near the river elsewhere below there are disturbed in numerous places.

Green river has three tributaries of importance in Webster county. These are Pittman creek, Deer creek and Graves creek. Of these Pittman creek drains only a small area in the eastern edge of the county and is of least importance. Its drainage basin is simple and the stream itself is sluggish and weak.

Deer creek is much the largest of the three tributaries and with its numerous branches drains a very large area in the eastern and central northeastern part of the county. It is comparable to Craborchard creek of the Tradewater system in its large drainage area, numerous branches and complex history of stream changes. Deer creek heads in northern Hopkins county, flows north to a mile below Catesville where it leaves the Dixon upland and receives an important branch from the northwest, and then turns northeast in a course whose general direction is held until it enters Green river two miles above Steamboat Ferry. Its largest tributary is East Fork which likewise heads in northern Hopkins county, flows north past Slaughtersville to Belcourt where it leaves the Dixon upland, turns northwest and joins main Deer creek very near where a prominent tributary from the northwest, Knoblick creek, also enters Deer creek.

Knoblick creek heads on the low-lying Henderson upland in the central northern portion of the county about Poole, flows southeastward and crosses the high Sebree hills in a narrow, steep-sided trench. This course was taken across the Sebree hills either before they had risen to their present elevation or more probably when the Henderson upland stood as high or higher than the Sebree hills now stand. It is, in other words, more probable that the soft rocks of the Henderson upland have wasted away, than that the hard rocks of the Sebree hills have risen differentially since the course of Knoblick was assumed. In either case Knoblick is an antecedent stream in its course across the Sebree hills. South of Bald Knob it turns northeast

and follows the strike of some soft Carbondale shales for two miles, then resumes its southeast course, crosses a buried divide in a low ridge and enters Deer creek.

Adjustment of Deer Creek Drainage.

Deer creek flows in a broad valley until it crosess the L. & N. railroad. It then flows through a narrow gap before entering the flood plain of Green river. Instead of turning east at the railroad crossing, Deer creek originally turned north and followed the deep groove across the Sebree hills that is now occupied by the L. & N. railroad. It passed through where the town of Sebree now is and formed the main part of the original

NO. 6. ABANDONED STREAM CHANNEL OCCUPIED BY RAILWAY.

Looking north toward Sebree through an old abandoned channel of Deer Creek now occupied by the L. & N. R. R.

Graves creek basin. It is very probable that Knoblick creek after cutting across the Sebree hills and turning northeast, kept that course parallel to the hills and entered Deer creek from the southwest through a narrow pass cut in the conglomerate just south of Sebree Springs.

Unlike the readjustment of the drainage of the tributaries of the Tradewater, which it is believed occurred long before the Pleistocene ponding, it seems more probable that the readjustment of the Graves creek and Deer creek drainage took place after this ponding. It is believed that the diversion from its former course through the Sebree gorge occurred not as a result of stream capture but because during the period of ponding the local wash from the steep loess-covered hills on either side of this narrow gorge filled it to a higher level than that of the general open ponded area. When elevation permitted the drainage of the ponded area and the re-establishment of the streams, this higher filled part of the gorge at Sebree Springs became a divide and Deer creek turned east to the river by its present course, the deep pond filling burying and obliterating the former divide just east of the railroad. For the same reason Knoblick creek was diverted from its lower course just southeast of Sebree Springs and was enabled to go southeast across what had now also become a buried divide and join Deer creek several miles above where it originally joined it.

Graves creek, the third of the Webster county tributaries of Green river, drains a relatively small area in the northeastern part of the county north and northwest of Sebreee. It is today but the beheaded remnant of the once far larger stream that also included all of the upper Deer creek drainage, as has been explained in the preceding paragraph.

The original courses of all of the tributaries of both Tradewater and Green rivers were transverse to the structure. They flowed across beds or belts that were alternately hard and soft and in the course of time certain major adjustments affecting particularly Craborchard creek of Tradewater and Deer creek of Green river were brought about as have been related in some detail in preceding pages. In addition to these major adjustments of the drainage, there have been many minor adjustments. Small branches have grown out in many places along the softer beds and have etched their way down between the harder beds, leaving them standing in relief. Around the base of the Sebree hills much of the minor drainage is adjusted either to the strike of soft beds or to fault planes. This is particularly true to the

north, northeast and southwest of Marksville. It is equally true in many places in the upland region from Wheateroft to Providence.

Another of the minor stream adjustments that is very common where structural conditions are appropriate is for small tributaries to prolong themselves by headwater erosion up long, gentle dip slopes. In the southwestern end of the county, for example, where the rocks dip to the northeast, lateral stream have first eaten their way along the strike in soft beds parallel to the harder beds and then tributaries of the next generation have grown out from them and now flow down the slope of the hard beds to the northeast. This is strikingly shown just north of Providence, to the east of Hopewell church, and at numerous other places.

Relief.

The deep carving of the surface by Tradewater and Green rivers and their larger tributaries together with the more minute etching of the minor streamlets and the filling and levelling up during the period of ponding have together given the surface its present relief and separated it into several areas of upland and lowland that will be described in later pages.

The general surface of the county may be described as a rolling to hilly upland thoroughly dissected by a system of many branched streams along which there are broad flat lowlands that usually extend well up to the heads of the streams and that are in many places so flat that large areas of them are poorly drained and swampy.

The distribution of upland and lowland is due primarily to differences in the resistance the rocks have offered to erosive agencies. Where the rocks are hard or, if soft, where they are protected by a rim of hard rock, the surface is an upland. Where they are soft they have worn away and form a lowland. The individual uplands and lowlands are intimately related to mining, agriculture and in fact all other of man's activities in the region and will be named and described in some detail in succeeding pages.

The lowest point in the county is on its southwestern side where Tradewater river leaves it about three miles north of Blackford. Low water elevation there is about 322 feet above

sea level. The flood plain along Tradewater has an elevation of 350 to 355 feet. On the northeast side Green river has a low water elevation of about 345 feet where it leaves the county near Quinn's ferry. The flood plain of Green river has an elevation of between 380 and 385 feet. The elevation of Highland creek where it leaves the county at the angle in the northwestern boundary is about 375 feet. Its flood plain there has an elevation of about 385 feet. The gradients of the tributaries of both of these rivers are very low even up nearly to their heads. This low gradient is due to the recent ponding of the entire drainage described on page 34.

The highest point in the county is some three miles southwest of Sebree where the elevation is slightly over 640 feet. The higher parts of the uplands are generally from slightly under to slightly over 600 feet in elevation. The lower parts of the uplands are in places about 500 feet or even somewhat less while arms of the lowlands project in a number of places into the very heart of the uplands at elevations of about 400 feet.

The extreme relief in the county from lowest to highest point is accordingly about 325 feet. The average relief measuring from lowland to adjacent upland is usually not over 150 to 200 feet and in many places not over 100 feet.

Taking the county as a whole the surface slopes are usually gentle. Only in certain places are they abrupt and such places are due to hard sandstones that have resisted erosion and produced steep scarps. Along such scarps the sandstones here and there project in bold cliffs. On the southwestern side of the county these scarps face to the southwest because formed by rocks dipping to the northeast, while on the northeastern side they face to the northeast because formed by rocks that are dipping to the southwest, as may be seen in Plate No. 10, page 25.

The surface of the county may be divided from southwest to northeast into the following topographic units: the Tradewater lowland, Providence upland, Lisman lowland, Dixon upland, Onton upland, Deer creek lowland, Sebree upland, Henderson upland and Green river lowland. They will each be described in serial order.

Tradewater Lowland.

This lowland extends from northwest to southeast across the southwestern end of the county. Owing to the windings of Tradewater river it varies in width from a maximum of four miles at Golds to a minimum of practically zero at Belleville, where the river swings hard against the foot of the bluffs that form the edge of the succeeding Providence upland belt. The Webster County part of this lowland is bounded by the Tradewater on the southwest and on the northeast by a nearly straight line of bluffs that run from beyond Sullivan in Union county southeastward past Virginia, Golds, Hopewell church, Rice's Mill and Belleville to Yarbro and beyond. The larger part of this lowland is included in the deeply filled alluvial flood plains of Tradewater river and Craborchard creek and other tribut-

NO. 7. TRADEWATER LOWLAND AND PROVIDENCE UPLAND.
The lowland and upland meet in a gently rounded slope.

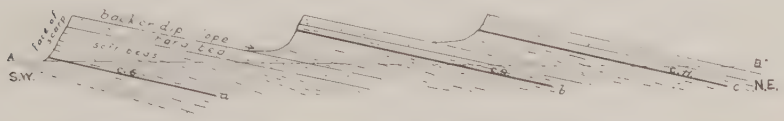
aries. A minor part of the lowland consists of low rolling hills that project up through the alluvial filling like islands. The two largest groups of these low hills lie to the north of Blackford and to the southeast of Craborchard creek. One or two other smaller isolated hill areas occur on the lowland. The general surface elevation is a little over 350 feet, and the low hills rise usually not over a hundred feet above this general surface level. Most of the lowland is cleared and cultivated. A typical view may be seen in plate No. 7, which also shows the bordering edge of the

Providence upland. There is very little waste area either from swamps or steep rough slopes. The belt forms a lowland because the rocks are largely shales and hence are softer than those on either side and have worn away faster. Since these rocks dip to the northeast wherever among the shales a bed of sandstone occurs it resists erosion and forms a low hill that will usually have its steepest slope on the southwest side where the hard bed projects up into the air. In this lowland, rock exposures are not abundant since the pond filling and upland loam or loess conceal most of the underlying rock. Coal number 6 crops out along the northeastern margin of the lowland. The streams that cross this lowland are tributary to Tradewater. They flow on deeply filled surfaces and show no adjustment to structure. The area of the lowland is about 20 square miles.

Providence Upland.

This upland lies just northeast of the Tradewater lowland and crosses the county from northwest to southeast in a belt that is three to five miles in width and twelve miles in length. Its area is between 45 and 50 square miles. The southwestern margin of this upland is a bold, well defined scarp overlooking the Tradewater lowland, while the northeastern margin is an indefinite line along which the upland dies away and merges into the succeeding Lisman lowland. The upland surface has been so thoroughly dissected by erosion that scarcely any remnants of its former flat surface remain. The tops of the hills that now compose the area indicate that the former upland surface had an elevation of about 580 feet near Providence and sloped northwestward to an elevation of about 500 feet near Wheatcroft. These upland hills arrange themselves into three parallel ridges that must have formerly been continuous and well nigh perfect but are now much broken by long continued erosion. Each ridge marks the outcrop of beds of harder rock between which the softer shales have been etched into longitudinal valleys. As the rocks dip northeast the ridges have steep scarp-like faces to the southwest and slope back more gently to the northeast. Each of these ridges has at the foot of its steep southwest slope the outcrop of an important coal seam. Near the foot of the first ridge, bordering the Tradewater lowland, is the outcrop of Owen's

number 5 coal—now called number 6—near the foot of the second ridge is the outcrop of number 9 coal and near the foot of the third ridge the outcrop of number 11 coal as may be seen in plate No. 8. The ridges serve, then, as markers or guides to the outcrop of the coals. Most of the mining in the county is in this upland and on the latter two ofthese coals.



NO. 8. CROSS SECTION OF PROVIDENCE UPLAND.

It is composed of three monoclinal ridges or cuestas. A is the Tradewater Lowland; B the Lisman Lowland; a, b, and c, are coals 6, 9 and 11, respectively; d is the Sebree Sandstone, and e the Anvil Rock Sandstone.

The drainage of the Providence upland was originally to the southwest or transverse to the strike of the outcropping rocks. We have seen in discussing drainage adjustment that two of the three main tributary streams were beheaded by the third one, Craborchard creek. The drainage today is of three types. Craborchard, Whitesides, Owens and several smaller have cut gaps in the upland ridges across which they flow. Other small streams flow northwest or southeast along the outcrop of soft shales parallel to the strike of the rocks and are adjusted to the structure. Still other smaller streams flow down the dip of the beds to the northeast and are also adjusted structurally as dip-slope streams.

While the larger part of this Providence upland is cleared and in cultivation yet there is a considerable part, especially on the steeper hills and rougher slopes, that is still forested. Drainage is good and exposures of rock are more abundant than in any other part of the county. Wheatcroft, Clay and Providence are on this upland and the last of these gives the upland its name.

Lisman Lowland.

This lowland, named for the town of Lisman, lies northeast of the Providence upland and is bounded on the northeast by the Dixon upland. It varies from two to five miles in width and has an area of between fifty and sixty square miles. It is one of the most clearly defined topographic divisions of the county. Its

general surface elevation varies from about 365 to 390 feet. The lowest part is a pond-filled surface much of which was originally swampy, but a good part of which has been ditched and drained. The largest swampy area remaining is nearly six miles long and from one-half to one mile wide and is known as Slover creek.

Low rounded hills project through the valley filling at a number of places. These hills are usually covered with loess so that rock outcrops are rare and unsatisfactory. The soil is good, and where properly drained yields excellent crops. Much of it is cleared and in cultivation. The main roads have been graded up and ditched. In the dry weather of summer and fall they are good, but in the wet weather of winter and spring they are apt to be bad.

NO. 9. TIPPLE OF CLIFTY CONSOLIDATED COAL CO.

A shaft is sunk to coal No. 9 just where the Providence upland from which the photograph was taken joins the Lisman Lowland, which may be seen in the distance.

In origin, this lowland coincides with the outcrop of the Lisman formation, which consists very largely of soft shales that have yielded readily to erosion. The outcrop of number 14 coal, the Baker coal, occurs along the southwestern side of this lowland but it is everywhere covered and concealed by recent deposits. The depth of the alluvial filling is not known in many places, but it may be as much as 100 to 150 feet. Water wells find alternating beds of sand and clay in places and get water

from the coarser beds probably near the base of the filling. It may be seen in the distance in plate No. 9, taken from the edge of the Providence upland.

Dixon Upland.

This is much the largest topographic division of the county. It crosses the center of the county from northwest to southeast and has a width of from six to eleven miles and an area of about 140 or 150 square miles. This upland is structurally a broad synclinal trough whose edges are formed by the outcrop of the Dixon sandstone as may be seen in plate No. 10. The preservation of the upland is due to the protecting agency of this hard sandstone rim for the surface rocks within it are mostly soft shales. Slopes from the upland to the adjacent lowland on either side are usually steep.

NO. 10. CROSS SECTION OF DIXON UPLAND.

This ideal structure section shows how the surface of the Dixon Upland, b, b, b, is protected by the outcropping edges of the Dixon Sandstone, c, c, c, which forms a scup overlooking the Lisman Lowland, a, on one side and the Deer Creek Lowland, d, on the other.

The general surface of the Dixon upland had an elevation of close to 600 feet but it is now so deeply and thoroughly dissected that only the higher points reach this level. The drainage is of dendritic type and flows in part to the Tradewater and in part to Green river. The larger streams have developed broad, flat flood plains that extend back well into the very heart of the upland. Much of the area is cleared and farmed but a considerable part is still wooded, especially along the steeper slopes adjacent to narrow, deep stream cuttings . Loess blankets the surface and somewhat smooths the outlines of the hills, though in many places it is cut through by gullies and the underlying rock thereby revealed. The soil is not so good as on the lowlands but it is better drained and is capable of improvement with ordinary care. In a few places the soft Bald Hill clay shales just beneath the Vanderburg sandstone weather into very poor soils. There are no coals of importance at or near the surface.

Onton Upland.

This upland occupies a triangular area in the eastern part of the county and extends south into Hopkins county. It lies south of Deer creek and but for the valley of the East Fork of Deer creek, which bounds it on the west, it would be considered a part of the Dixon upland. Southward in Hopkins county it becomes a part of the eastern prolongation of the Dixon upland. The rocks of this upland are mostly soft shales that have yielded greatly to erosion. Pittman creek working backward along the outcrop of the soft Bald Hill shales close beneath the Vanderburg sandstone has almost dissevered the northern part of the upland. The highest hills along the county line, a mile and a half southeast of Belcourt, are capped and held up by this Vanderburg sandstone. They reach an elevation of 540 feet but elsewhere the Onton upland scarcely reaches 500 feet. The rocks dip gently to the south. Among them there is a coal of some local importance here called the Belcourt coal. The surface is a rolling to a gently hilly one and is largely cleared and cultivated. Its area is between 15 and 20 square miles.

Deer Creek Lowland.

This lowland lies north of the Dixon and Onton uplands, and south of the Sebree upland. On the east it merges into the Green river lowland of which it may be considered a lateral prolongation. Its general elevation is between 380 and 400 feet and its area is between 20 and 25 square miles. This lowland has developed in the soft shales of the lower part of the Lisman formation and curves with the outcrop of these shales to the northwest at Marksville, around the western end of the Sebree anticline and upland. Deer creek once cut out these shales to a level much below the present surface. This surface is the result of pond filling and is remarkably flat. This lowland is now being drained, cleared and put into cultivation. Prologations of this lowland pierce the surrounding uplands deeply along East Fork, main Deer creek, Havana creek and Knoblick creek. On its northern side both east and west of the Louisville and Nashville railroad some low hills or ridges project above the general lowland surface. These hills are due to harder beds as-

sociated with the horizon of coals 11 and 12. These coals are often absent in this vicinity as will be described on pages 95 and 96. Close north of them but buried here by alluvial filling is the outcrop of number 9 coal.

Sebree Upland.

This is one of the smallest and decidedly the roughest of the several uplands in the county. It extends from Steamport Ferry on Green river westward to Marksville. Sebree is on its northern edge. This upland is roughly some nine miles long by about two miles wide and has an area of about 20 square miles. Its higher portions have an elevation usually of between 550 and 600 feet and its highest point is slightly more than 640 feet and is the highest point in the county. Much of the higher part of the Sebree upland is underlaid by the Sebree sandstone which has been folded upward into a long anticlinal arch whose structure may be seen from the contours of plate 21, on page 126. This upland has been cut in two by Knoblick creek and again at Sebree by an abandoned channel of Deer creek, as has been described on page 17.

NO. 11. WEATHERING OF CASEYVILLE CONGLOMERATE.

The top of the Caseyville conglomerate near Sebree shows its variable texture by its irregular weathering.

Much of this upland west of Sebree is cleared and cultivated. East of Sebree it is much rougher and is largely wooded. The northern edge is formed by the Rough creek fault described on page 127 and beyond it lies the Henderson plain, or low upland.

Henderson Upland.

The northern edge of the county includes a small part of a plain that stretches for miles northward across Henderson county and may be called the Henderson plain. The part included in Webster county is from two to four miles wide and extends from the Union county line eastward to Green river lowland. Its southern margin is formed by the series of broken hills that run eastward from Tilden to Sebree and belong to the Dixon and Sebree uplands.

NO. 12. SEBREE HILLS IN GENTLER MOOD.

The hills west of Sebree are rolling and may often be cleared and farmed up to their summits.

The general surface of the Henderson upland is gently rolling, except in its eastern part, where it becomes hilly in the vicinity of Graves creek. The average elevation is between 450 and 500 feet while one point a mile northeast of Poole is 560 feet above sea. The drainage is partly northwestward by Highland creek to the Ohio and partly eastward by Knoblick and Graves creeks to Green river. The alluvial plains along these three creeks are a half mile to a mile wide and meet the border-

ing uplands in such low slopes that it is often difficult to determine where to draw the line between the two. Practically all of this upland has been cleared and is in cultivation. There is no waste area from roughness and practically none from erosion and gullying. Exposures of any kind of hard rock are very rare and always of small extent.

Green River Lowland.

Green river forms the eastern boundary of the county. It flows in a winding valley whose flat bottom is one to two miles wide and whose sides rise with steep but irregular slopes to the bounding uplands. East and north of Onton this Green river lowland is about two miles wide. Near Steamport ferry the Sebree hills close in upon the river and narrow the lowland to a fourth of a mile. North of there it widens again in the vicinity

NO. 13. ROUGH UNCLEARED SEBREE HILLS.

East of Sebree many of the hills capped by the Sebree sandstone are too rough and steep to be cleared.

of Graves creek to a mile or more and then soon narrows once more until near Quinn's ferry it is only some two hundred yards wide. Where the river first reaches the county it is on the east side of its valley and all of its flood plain is on the western or Webster county side. Between Roland and Steamport ferries the river crosses to the west side of the valley and continues on

that side until it leaves the county so that practically all of its flood plain north of Graves creek is on the eastern or McClean county side of the river.

The surface of the Green river lowland is unusually level and has an elevation of about 385 feet where the river first touches the county and 380 feet where it leaves it. The continuity of this lowland surface is broken by two small hills just northeast of Onton that rise slightly above it and by another somewhat larger one that is found just north of Deer creek. These low gentle hills protrude thru the valley filling that has almost buried and obliterated them. This filling is in places over a hundred feet deep and was deposited, at least in large part, when the valley of Green river was ponded during one of the closing stages of the Glacial age. Further details concerning the alluvial filling may be found on pages 33 and 122 of this report.

CHAPTER III.

TOPOGRAPHIC HISTORY

The topographic features of the county described above contain a more or less complete record of the processes by which they were fashioned and a close study of these features will reveal more or less fully the history of their formation.

The oldest topographic features of the region are the higher portions of the general upland surface. These higher areas rise to about 600 feet above sea level, though some stand slightly above and others slightly below this level. They mark, in an approximate way, an old plain whose continuity might be restored by filling up all of the lowlands to the level of these higher upland points. The existing summits doubtless do not quite reach up to the position of the old plain, since they have lost somewhat in elevation since the old plain began to waste away.

This old plain was once widely extensive over this portion of the Mississippi drainage basin and was formed by the down wearing of the surface thru long preceding ages until it stood but little above the level of the sea. When this down-wearing ended there were in Webster county probably no remnants of any harder rock left standing above the general surface, although such remnants were to be found in nearby areas, especially across the Tradewater to the southwest where areas of hard Pottsville conglomerate remained as unreduced ridges or other elevated areas.

Such an old, worn-down surface is called a peneplain and this one was formed in the latter part of Tertiary time and is known as the Tertiary peneplain. It is the oldest topographic feature found in the county and has suffered so much from subsequent erosion and other changes that few remnants of it now remain and it is now impossible to describe the old plain with much detail. Its general slope was almost certainly westward or northwestward. The Webster county portion of it was probably drained by Green and Tradewater rivers, though these streams may then have been larger or smaller than they now are and probably did not then exactly coincide with their present

position, though they were probably nowhere more than a mile or two away from their present position. They of course then flowed practically on the old peneplain level some 250 to 300 feet above their present position.

The period of erosion that produced the Tertiary peneplain just described was ended by a general uplift of the land in late Tertiary time. It is not clear just how high the surface of Webster county was raised by this uplift. It is possible that the uplift at first was not great and that after this initial uplift of probably less than a hundred feet and possibly much less than this amount, there was a period of crustal quiet, during which the streams that had been reinvigorated by the uplift cut down as far as possible and then began to broaden their valleys. The streams were then further invigorated by renewed uplift or tilting so that they carried a mass of rounded, water-worn gravel and deposited it in the broad and very shallow valley that they had formed. This deposit consisted of sand and well-rounded sandstone and chert gravels ranging from an average of 1 to 2 inches to a maximum of 3 or 4 inches in diameter. With the sand and gravel there was considerable ferruginous material—probably leached from the surrounding peneplained surface. A few very small remnants of this gravel deposit are found in the eastern part of the county adjacent to Green river. Part of it is cemented by the ferruginous material into a limonitic conglomerate that is found in thin crusts or small broken masses.

It is possible that instead of having been deposited after a partial uplift and pause, this old river gravel may have been the result of the initial uplift of the Tertiary peneplain, in which case it is necessary to suppose that the streams then flowed in broad valleys, cut only very slightly beneath the old peneplain surface and that immediately after uplift they floored over these broad shallow valleys with gravels and sands brought from their upper courses. There is too little of this old gravel left in the county to decide between the two alternatives though the former seems to the writer the more probable.

These gravels are found on the ridge south of Deer creek and may be seen there at several places in the road from Sebree to Slaughtersville. They are poorly exposed and other areas may exist concealed beneath the surface loam. Other small

areas are found farther down Green river in Henderson county. It is believed that these gravels belong to the Lafayette and that their deposition marked an episode in the topographic history of the region during Pliocene time.

This episode was brief and was ended by further uplift. Since then, whether as a result of a single upward movement or, as is more probable, of successive ones separated by pauses with or without intervening downward oscillations, the region has been elevated high enough to let Green and Tradewater rivers cut their channels down 100 to 175 feet beneath their present beds. It is very probable that this uplift permitted the streams to cut down to a level only slightly—perhaps 10 to 30 feet—below the level of the present lowland surface and that there was then a pause while the valleys were widened to approximately the condition in which they are found today, after which a further uplift allowed the main streams to sink a narrower gorge or valley within the broad one that had just been formed. In numerous sections across the Tradewater valley rock in place is found at such short intervals that it would seem impossible that there could have ever been an old broad valley there cut very far below the present flood plain level. Borings, however, show alluvial filling 175 feet thick near Sturgis and about 100 feet thick even up at Dawson Springs. The same is true of Green river valley. Sandstone, shale or limestone is found almost at the surface at a number of places well away from the valley sides. Shale is found in Deer creek a half mile above the Sebree-Onton road and is seen at low water at Steamport ferry. Sandstone is found in the banks of Graves creek some 200 yards above its mouth and fusulina limestone is found only a few rods away practically on the flood plain surface, yet a well a half mile farther up Graves creek went thru 104 feet of mud and clay without reaching bed rock and the Heilman drill hole on the bank of Green river a mile below McKinley in McClean county passed thru 113 feet of gravel and quicksand before reaching the rock floor.

This uplift, downcutting, and valley widening occurred in early or middle Pleistocene time.

Late in Pleistocene time the land sank and the streams began to fill up the valleys they had just excavated. The earlier

part of this filling was a simple flood plain deposit of sand, gravel and clay while the latter part was a fine silt due in some measure at least to the ponding of the Tradewater and Green rivers and their tributaries. This filling attains a thickness of 100 to 175 feet in the valleys of Green and Tradewater rivers and from the scanty records at hand would seem possibly to be thicker in the Tradewater valley than in the Green valley though it is not certain that the deepest part of either valley floor has yet been revealed by the drill. It is practically certain from conditions found elsewhere in this general region that both the downcutting last described and the subsequent partial filling of the valley thus cut were complex rather than simple processes, but too little is known of the valley filling in Webster county to attempt to give the history of the accompanying topographic changes in greater detail.

At about the close of the above mentioned period of ponded stream silting by which the present broad, flat valleys were formed, there came a deposit of fine, yellowish brown loam, borne largely or entirely by the wind. This deposit is 6 or 8 to 15 or 20 feet thick. It forms a mantle over the uplands and is believed to merge into the surface part of the material filling the broad valley lowlands. This loam has not greatly modified the topography though it has filled and obliterated the minute erosional irregularities of the preceding surface and given to the hills a somewhat more rounded outline than they would otherwise possess.

The latest event in the topographic history of the area has been a slight uplift of the region that may still be in progress. This uplift has permitted the larger streams to cut slightly into the deep valley fillings and in places where they now chance to flow near the edge of their old valleys, has laid bare the underlying old bed rock which the streams are now scouring away. The Tradewater, for example, is scouring on Pennsylvanian sandstone or shale at practically every ford in the county and at numerous other points as well. Most fords, indeed, were located at places where the river is cutting down on old hard rocks since such places furnish a good firm bottom for crossing. On

Green river Pennsylvanian shale is left bare at low water at Steamport ferry and it is probable that the bottom of the river there is on sandstone.

Another evidence that these streams are cutting down their channels slightly is the fact that some portions of their broad flood plains are either never reached today by floods or are reached and covered so seldom that the deposits then laid upon them are not as great quantitatively as those removed by erosion in the intervals between such extraordinary floods, so that the flood plains of the larger streams are wasting rather than building. Such flood plains may be called extraordinary flood plains. They are evidently decadent.

On the other hand, the flood plains of the small streams that head well back among the hills of the uplands are being built up by the deposit of sand and clay carried into them in increasing volume from many parts of the upland as a result of the increased erosion of the steep slopes that have been cleared and farmed in the usual careless fashion. The head water portions of Caney, Craborchard, Farmer, Havana, Deer, Sugarcamp and other creeks show this tendency to build up or aggrade their narrow flood plains, and at many places along the margins of the broader valley lowlands broad sandy fans are pushing out from the base of the bordering uplands as the result of increased erosion because of man's activities in the region.

CHAPTER IV.

INFLUENCE OF TOPOGRAPHY ON MAN'S ACTIVITIES.

The topography of the county shows a direct relation to man's activities in a number of ways. In many cases the topography has influenced or controlled these activities by predetermining where or how man might work with greatest facility and economy. In other cases the topography has interposed obstacles to man's activities which he has overcome only by the expenditure of extra time and energy.

Topographic influence is seen in the original settlement of the county. The uplands offered well drained, healthy sites for habitation and have always attracted more settlers than the lowlands. Most of the early towns, such as Vanderburg, Dixon, Providence and Poole, were founded on the uplands. Another location highly attractive to the pioneer was the river banks. Flat bottomed boats could easily reach these landings and they became naturally places of barter or trade as well as gateways by which those earlier settlers who floated down the Ohio might enter the country. Hunting, trapping and fishing centered about them and if the locality could be made a general place of crossing, such as Steamport for instance, ferriage became an additional source of revenue. In some cases the location of a mill on or near the mouth of some small stream became the determining factor in the location of some early community. Conditions have changed now and with them many untoward changes have befallen these early settlements. Railways have taken the place of the rivers as the chief highways of travel and transportation and river settlements have fallen to decay, while new towns have sprung up along the railroads and become the centers of trade. Belleville, Montezuma and Logansport on the Tradewater are chiefly memories today. Steam generated by coal has taken the place of water for power and sites once valuable for water mills are generally abandoned. At Gold's, for instance, the old millstones, each a single block of basaltic lava probably imported from Europe by way of New Orleans, are the sole reminder of its importance in former times as a milling point.

In early days the lowlands away from the river banks were generally undrained and unfit for agriculture. They were left as uncleared swamps. It is only in the last few decades that extensive ditching as seen in plate No. 14, has been done to reclaim

NO. 14. DRAINAGE DITCH.

Draining converts useless swamps into fertile fields and makes possible better roads and better health.

these lands. Most of these undrained lands become exceedingly fertile when properly ditched and the present trend of population is from the uplands toward the reclaimed lowlands. Already most of them have been drained and cleared, and it will only be a few years until the remaining undrained and uncleared areas along Slover and Deer creeks will be transformed into fertile farms. On the lowlands fields may be larger and may be cultivated with greater ease. The land there is usually more fertile than on the uplands and conditions for extensive farming there are in general more favorable. With thorough drainage the lowland becomes perfectly healthy as a place of residence.

The roads of the lowlands were formerly the worst in the county. Where ditched and embanked they have now become the best in the county during dry seasons but still need to be macadamized before they become good the year round.

In the roughest part of the uplands the topography controls the location of the roads and they generally follow the ridge crests of stream partings. This type is seen about Mt. Pleasant

church and near Mt. Gilead school, Vanderburg and Dixon. Where the uplands are somewhat less rough the topography is often disregarded and land lines become the determining factor in locating the roads. Owing to the shape, presumably of early land grants and patents, the land lines generally run northeastward and northwestward at somewhat varying angles and in consequence the rectangular road patterns follow the land lines and have the same orientation. Where the land is comparatively level, as in the lowlands and the gently rolling parts of the uplands, there is no objection to such a road system, but where it is used in some of the rougher parts of the uplands the roads become a series of short, sharp hills that make travel slow and laborious and prevent drawing heavy loads. The hilly rectangular roads in the Dixon upland west of Luzon illustrate this disregard of topographic influence very forcibly. In many cases a slight detour to right or left would enable such a road to follow a ridge crest and eliminate practically all of the steep grades on it.

In the Providence region where the upland consists of relatively narrow parallel ridges, the roads either keep to the longitudinal lowlands between the ridges, like the road from Providence to Clay, or they cross the ridges by following the valleys of the creeks that have cut gaps thru the ridges, such as Whiteside, Owens and other creeks.

The building and maintenance of good roads must always be more difficult in the uplands than in the lowlands and this must result in some degree of isolation always characterizing the upland region that will make itself felt in the schools, churches and social activities of the people of such sections as contrasted with lowland areas where communication is easier and more rapid.

The location of the railways shows the distinct influence of topographic control. The Illinois Central between Blackford and Wheateroft crosses the Providence upland by following the valley cut across this upland by Craborchard creek and from Wheateroft to Providence follows a longitudinal valley in the Providence upland. It reaches Dixon by following up the narrow valley of Farmer's creek. The Louisville and Nashville railway uses an abandoned stream channel to cross an upland

ridge at Providence and from Providence to Clay occupies for half the distance the same longitudinal valley occupied by the Illinois Central and then leaves this valley by a breach made in its northeastern wall by a tributary of Slover creek. Northwest of Clay it follows the broad Lisman lowland well toward Morganfield. The main line of the Louisville and Nashville crosses the eastern end of the county by a series of lowlands, the narrowest and most picturesque portion of which is the abandoned channel at Sebree Springs once occupied by Knoblick and Deer creeks.

The most favorable location for towns under present day conditions is on the edge of the upland where the surface is rolling enough to give good drainage and where they may be readily accessible from both the upland and lowland and easily reached by the railroads that follow the lowland. Providence, Clay, Wheatcroft, Sebree and Slaughtersville are all thus situated. Towns on a high, narrow ridge like Vanderburg are practically inaccessible to a railroad.

It should not be understood that the topography is the sole condition that has determined the growth of Webster county towns. It is merely one—and a very important one—of several conditions. Geology has had a hand in the growth of Sebree, Providence and Clay and is alone responsible for the founding and development of Wheatcroft since important coal seams outcrop at or near each of these places and have led to extensive mining developments. Lisman and Slaughtersville, in favorable topographic situations, are without readily accessible coal and hence are deprived of mining as a stimulus to growth.

The fact that it is the county seat is, independent of its topography, a factor favoring the development of Dixon. Nor is accessibility the sole favorable topographic feature. A town on a high ridge like Vanderburg has by its topographic position good drainage, healthfulness, pure breezes and far reaching views on all sides that give it a charm that places in the lowlands do not possess.

The topography of the county is of importance in another way that is neither controlling nor causative but merely guiding, in that it may be used to indicate even to the man without a knowledge of geology, where the several commercial seams of

coal outcrop. It will be remembered from the topographic description in preceding pages of this report and may be seen from plate No. 8, that coal number six outcrops near the base of the steep scarp overlooking the Tradewater lowland, while coals nine and eleven outcrop on the slope of similar parallel but less abrupt scraps within the Providence upland; and that these same coals, nine and eleven—or the horizon of the latter when it is absent—outcrop again along the west end and the south side of the Sebree upland with certain characteristic topographic relations that may be readily recognized.

In these and other ways that might be given the topography of the county is intimately related to the activities of the people.

CHAPTER V.

GENERAL GEOLOGY

Previous Geological Work in Webster County. It is probable that some of the coals of the lower Tradewater region have been known from the days of the earliest settlement in that region since some of them occasionally show in natural outcrop along stream channels and gullies. By 1854 when the first Kentucky Geological Survey was established under Owen there were already a number of mines such as the Casey, Bell, Cook and Mulford in active operation in the Caseyville-DeKoven region. The importance this region had thus early assumed in the mining of coal doubtless was an important factor in leading Dr. Owen to inaugurate the work of his survey by a geological examination of this western coal field, and during the existence of his survey from 1854 to 1859 more geological, paleontological and topographic work was done there than in any other section of the state. The results of this work published in Owen's four reports remain, even today, as the only detailed discussion of the geology of most of that region.

In his first report Owen gives with considerable detail a section from the base of the coal-bearing rocks up to the Anvil Rock sandstone over what we now know as No. 12 coal. His assistant, S. S. Lyon, who made a detailed topographic map of Union county in 1854 and 1855 included in his report published in this same volume, a considerable amount of detail as to the distribution of the coals of the county which then included the southwestern part of what is now Webster county. Analyses of the Union county coal were given and the Rough creek anticline, previously studied by Owen in the Sabine region of Illinois, was recognized by him in Union county opposite Shawneetown and traced east to the Bald Hills. From there Lyon traced it on to the eastern edge of Union county.

In Owen's second report, although most of Lyon's work was confined to what is now Hopkins county, he gave some detail as to the coals about Providence and discussed the correlation of the Bell, Cook and Battery Rock coals, concluding that they were all different.

In the third report Owen gave a detailed section of the thousand feet of coal measures below the Anvil Rock sandstone and added a section of some five hundred feet above it which he called his upper measures and recognized that in the Union county region these latter measures were largely barren of workable coals. To designate the more important coals of this section, he introduced the system of numbers by which the coals of the region have ever since been known. He traced a number of the more important coals eastward into what is now Webster county. In this report Lesquereux described the preliminary results of the study of the paleobotany of the field shortly before undertaken by him and gave a correlation of the coals of the region, while E. T. Cox made a report on the marine fossils of the western coal field, found associated especially with coals five, nine and eleven.

In Owen's fourth report, Lesquereux gave in more detail the stratigraphic results of his study of the coal flora and devoted some pages to local observations on the various coals of what is now southern Webster county.

When one considers the time and the circumstances under which Dr. Owen worked it is remarkable that the detailed section of the lower portion of this western coal field fully elaborated by him in his third report should stand today without material change in its essential details. Much of the region was then wooded, roads were poor, there were almost no borings and only a few mines had been opened, and yet in a short while he established in Union county what must always be the type section not only for western Kentucky but for southern Indiana and Illinois as well.

Worthen[3] and Cox[4] both published criticisms of this general section of Owen in which they contended that a part of the section was repeated by faulting that had escaped recognition by Owen. The erroneousness of this criticism has been pointed out by Norwood[5] by an examination of the Caseyville-DeKoven type section. It is also stated somewhat fully by the writer in his Tradewater Reconnoissance report.

[3] Ill. Geol. Survey, Vol. 3, pp. 1-9, 1868.
[4] Amer. Assoc. Adv. Sci., Proc. for 1871, pp. 236-252, and Sec. Rept. Ind. Geol. Surv., pp. 164-173, 1871.
[5] Rept. Inspector of Mines of Ky., pp. 90-97, 1893.

Geological work was resumed by the state in 1873 under the direction of Professor N. S. Shaler and was continued until 1879. The results of this work are contained in six volumes of reports and in a few separate memoirs. Professor C. J. Norwood was placed in charge of work in the western coal field and soon became acquainted with the unusual difficulties of work in much of that field arising from the complex faulting and the dearth of exposures. He had made and reported on a study of the geology along the Louisville, Paducah and Southwestern Railway[6] (now the Illinois Central); on the geology along the north and south running railways[7] of western Kentucky, and on the geology of a part of Ohio county[8] before the Survey was discontinued. He found a well marked fault on Rough creek in 1874 and in 1876 traced it westward to Sebree and suspected that it would unite with the Union county fault traced by Owen and Lyon.

Work on the western coal field was cut short before much more than a beginning had been made and part of what had been done was left unpublished when the Shaler survey was ended.

Little or no additional field work seems to have been done in the region by the Proctor Survey during its rather lengthy existence of twelve years (1881-1892) but a reprint of all of the reports on the region by the Shaler Survey was issued.

The next contribution to our knowledge of the western coal field was made in 1893 by Professor Norwood in his "Key to the Western Coal Field"[9] where both the general section and the more important coals are described and several plates of sections are given showing correlations in western Kentucky and southern Illinois. In the report for 1895 (pp. 252-270) and in that for 1901-02 he gives again the general section for the western field (pp. 312-313). Meantime he had published in the 1889 Mine Inspector's Report an article by Mr. J. D. Atkinson on coke making at Earlington. This was reprinted in the 1895 report. A description of the Campbell coal washer at Earlington is given and the results of testing some of the coals of the western field for coking and steam are added.

[6] Ky. Geol. Surv., n. s., Vol. 1, pp. 355-448.
[7] Ibid. n. s., Vol. 3, pp. 285-338.
[8] Ibid. n. s., Vol. 5, pp. 77-124.
[9] Rept. Inspector of Mines of Ky., pp. 90-105, 1893.

When the state resumed geological work in 1904 under the direction of Prof. C. J. Norwood it was early determined to make a detailed survey of the western coal field. To this end a topographic survey in cooperation with the U. S. Geological Survey was soon begun and geological work was undertaken by the director in person assisted at first by S. A. Denny, and later by W. F. Pate, F. J. Fohs, F. M. Hutchinson, J. H. Gardner and the present writer. Work was thus started in several parts of the western coal field. Of the results of this work it may be said that many new facts concerning the geology and structure have come to light. The present report embodies the result of the writer's work for parts of three field seasons, that of 1909 being spent in a general reconnoissance of the Tradewater river region, that of 1910 being devoted to detailed work in Webster county, and that of a part of 1911 supplemented the 1910 work in certain parts of Webster county where especial difficulties had been encountered, and included a brief reconnoissance of Henderson county. The history of the report on Webster county rendered by the writer in 1912 has been given in the opening pages of this report.

Since this manuscript on Webster county was originally prepared there have been published by the Kentucky Survey a number of reports on portions of the western coal field. They are:

Bulletin 19. Coals of the Central City, Madisonville, Calhoun and Newburg Quadrangles, by F. M. Hutchinson, 1912.

Bulletin 20. Coals of the Hartford Quadrangle, by James H. Gardner, 1912.

Economic Geology of the Tell City and Owensboro Quadrangles, by A. F. Crider in Ky. Geol. Survey, Ser. IV, Vol. I, Pt. I, pp. 262-316, 1913.

Report on the Geology and Mineral Resources of the Dawson Springs Quadrangle, by A. F. Crider, Ky. Geol. Survey, Ser. IV, Vol. II, Pt. I, pp. 7-67, 1914.

Geology and Economic Products of the Earlington Quadrangle, by A. F. Crider. Ky. Geol. Survey, Ser. IV, Vol. II, Pt. I, pp. 69-153, 1914.

Reports on the Coals of the Nortonville, Drakesboro, Dunmor and Little Muddy Quadrangles, by A. F. Crider. Ky. Geol. Survey, Ser. IV, Vol. III, Pt. I, 1915.

In co-operation with the U. S. Geological Survey there was published by the Ky. Geol. Survey in 1916, a report on the Geology of the Shawneetown Quadrangle in Kentucky, by Wallace Lee.

The Coal Industry in Kentucky, by W. R. Jillson, State Geologist of Kentucky, 1922.

Private capital has done much for the development of this western coal field and by such development has added greatly to our knowledge of both the structure and economy geology of the field. Thru ignorance of geological conditions much money has been lost in ill-advised ventures, a large portion of which could certainly have been saved to its owners had the state done years ago what it is now doing to make the geology of the region known. Parties have recently optioned or bought lands for coal where the nearest commercial coal is one thousand two hundred feet below the surface. Others have recently drilled for coal where it is equally deep, and yet hoped to reach it in one hundred or two hundred feet. Some have opened a surface coal for No. eleven when that coal lay one thousand feet below them. Others try for No. 9 or No. 11 where it is entirely absent. Oil wells have been put down where there was not one chance in a hundred to get oil, while much more promising oil territory lay unknown within a mile or two.

So far as the writer is aware nothing has been published in recent years by anyone directly on the general gology of Webster county, and except for the reports mentioned above by the Hoeing Survey which are largely confined to descriptions of coals, there has been very little published on any part of the western coal field so that recent literature on the area is very meager when its extent and economic importance are considered.

Stratigraphy.

All of the rocks that appear at the surface in Webster county are of sedimentary origin and all of them were formed under water except the beds of coal which formed in swamps and the surface loam or loess which was carried and deposited by the wind. There are no igneous rocks at the surface though it would not have been surprising had dykes of such rock been found along some of the fault planes of the Rough creek anticline since faults probably of the same age and of much less displacement in the adjoining county of Christian show igneous dykes in a number of places. It is entirely possible that igneous rock was forced upward along the Rough creek anticline when it formed, but if so none of it reached what is now the surface in Webster county. Igneous rock occurs as narrow dykes in some

coal mines in Saline county, Illinois, in the region traversed by the westward extension of the Rough creek anticline and may be associated in origin with this anticline.

A small rounded piece of crystalline rock may now and then be picked up on the surface in Webster county, especially about old Indian camps or village sites. Some pieces found by the writer were of granite while others were dark basic rocks such as diorite, diabase or gabbro. They were undoubtedly morainic material that had been carried southward by the Indians from the glaciated region probably of Illinois or Indiana. One or two large blocks weighing several hundred pounds each, found on low slopes near the edge of ponded lowland areas, may have been dropped from floating ice during the ponded period.

Now and then a man drilling a well reports having struck granite. Such reports in Webster county are all mistakes. The rock in such cases is merely an unusually hard nodule or layer very probably of impure, or bastard, limestone or of clay iron stone, chert, or even hard sandstone.

Age of the Rocks. The oldest rocks of the county exposed at the surface are of Mississippian age. They form an exceedingly small area, however, while in contrast in this respect the next oldest rocks, the Pennsylvanian, form the surface of much the largest part of the county. The next oldest rocks are certain very small areas of gravel of Pliocene age. These are succeeded by considerable areas of Pleistocene age and these in turn by the deposits now forming in the flood plains of streams and known as Recent or Alluvial. These will be discussed in the order above given and will be followed in the chapter on oil and gas by brief mention of some rocks older than the oldest exposed Mississippian ones that do not outcrop at the surface within Webster county but that may still be within reach of the drill and may be of economic importance in connection with possible oil and gas acumulations. This latter discussion will be found on pages 139 and 140.

It will be well to preface the detailed discussion of formations by a table giving the correlation of the Pennsylvanian rocks and a brief explanation of the various terms used therein, after which will be given such fossil evidence as has been secured as to the age of the rocks involved in the Pennsylvanian section. In

this connection see also the general stratigraphic section sheet. The details in the Caseyville part of this general section are taken from Lee's Shawneetown report since there are no exposures of any except the topmost beds of the Caseyville formation in Webster county and no core drill records exist for these lower rocks. In the writer's Tradewater river report he accepted on the assurance of previous workers the equivalency of the Bell and the Battery Rock coals and made no investigations on the Illinois side of the Ohio. According to Lee the Battery Rock coal is not the same as the Bell but is in the conglomerate below the Bell.

CORRELATION TABLE FOR PENNSYLVANIAN FORMATIONS

		U. S. G. S.; Murphysboro-Herrin, Ill. Folio 185, 1912.	Lee; Shawneetown Quadrangle. Ky. Geol. Surv., 1916.	Glenn; Bull. 17, Ky. Geol. Surv., 1912. (Written in 1910.)	Glenn; Rept. of Prog. for 1910-1911, Ky. Geol. Surv., 1912. (Written in 1911.)	Glenn; This Report. 1922.
PENNSYLVANIAN	Conemaugh	McLeansboro Formation 550′+	Henshaw Formation 150′+	Dixon Formation 200′+	Dixon Formation 340′ ±	Dixon Formation* 430′
			McLeansboro Formation 970′-1000′	Lisman Formation 900′-960′	Lisman Formation 900′-1000′	Lisman Formation 900′-1000′
	?Allegheny	Carbondale Formation 250′-300′	Carbondale Formation 367′	Mulford Formation 80′-125′	Mulford Formation 150′-250′	Carbondale Formation 230′-650′
				DeKoven Formation 150′-200′	DeKoven Formation 100′-400′	
	Pottsville	Pottsville Sandstone 420′ 510′	Tradewater Formation 594′	Tradewater Formation 420′-600′	Tradewater Formation 175′-700′	Tradewater Formation 175′-700′
			Caseyville Sandstone 511′	Caseyville Conglomerate 310′	Caseyville Formation 200′ ±	Caseyville Formation 200′-500′?

*It is possible that the upper part of the Dixon Formation is of Monongahela age. See page 54.

Correlation of Formations.

Mississippian. The exposures of the Mississippian in the county are all very small and are found along the Rough Creek fault where the rocks are greatly crushed and faulted. It has not seemed practicable to make any separation of these Mississippian rocks or map anything but one formation. This has been called Leitchfield.

Pennsylvanian. Reference is made on an earlier page to views of Owen, Cox, Worthen and others in the past as to correlations of the Pennsylvanian in this region. For present usage we need not go back more than a few years, and may confine ourselves to a few state or federal reports.

In Folio No. 185 of the U. S. Geological Survey on the Murphysboro-Herrin region in Illinois, prepared in cooperation with the Geological Survey of Illinois, Shaw and Savage divide the Pennsylvanian from below upward, as may be seen from the accompanying table, into the Pottsville sandstone, Carbondale formation, and McLeansboro formation. The Pottsvile is 420 to 510 feet thick and reaches upward nearly to the base of the Murphysboro (No. 2) coal, the equivalent of Owen's coal No. 5, but now known in West Kentucky as coal number 6. From the studies of the fossil plants by Dr. David White[10] it seems probable that the top of the Pottsville is slightly below the Illinois coal number 2, but the base of the underclay of this coal was taken in the above folio as a convenient formation boundary for mapping.

The Carbondale formation, 250 to 300 feet thick, reaches from the top of the Pottsville up to the top of the Herrin, or number 6, coal of Illinois. This coal is the same as the number 11 coal of West Kentucky. This formation is regarded as being of Allegheny age. Dr. David White[11] says that the Allegheny reaches up to the Illinois number 6, or number 7 coal,—that is to Kentucky number 11 or number 12 coal.

The McLeansboro formation extends from the top of the Herrin (Illinois number 6 or Ky. number 11) coal up to the top of the coal measures. It is regarded as being over 550 feet thick.

Next the present writer prepared a report in 1910 on the Tradewater river region that was published in 1912 as Bulletin

[10] Bull. 14, Ill. Geol. Survey, p. 294, 1909.
[11] Ill. Geol. Surv., Bull. 16, p. 179 and p. 289, 1910.

17 of the Kentucky Geological Survey. In the text of this report the writer suggests certain formational units on page 74 but does not there name these formations. Accompanying the report there is a sheet of vertical sections prepared slightly later where formation limits are slightly changed and formational names are given.

At base is the Caseyville conglomerate ending at the top of the massive conglomerate at Caseyville, and regarded as at least 300 feet thick. Above it is the Tradewater formation extending up to the base of the scarp-making sandstone some seventy-five feet above Owen's coal number 5, there named the Sebree sandstone. The section gives 580 feet, but elsewhere in the report the thickness is given 175 to 700 feet. Next comes the DeKoven formation, 155 feet thick and reaching up to the base of Kentucky coal number 9 (the number 5 or Springfield coal of Illinois). This division at coal 9 was chiefly one of convenience in mapping the most valuable coal in the area, though there is also a local erosional unconformity at this horizon.

The next formation is the Mulford, 110 feet thick and extending from the base of coal number 9 up to the base of the Anvil Rock sandstone, a short distance above coals numbers 11 and 12, where there is a marked unconformity.

Next the Lisman formation extends 960 feet from the base of the Anvil Rock sandstone up to the base of the Dixon sandstone, where another unconformity occurs. Above this unconformity the Dixon formation extends 200 feet or more to the top of the coal measures.

Next, the present writer prepared in 1911 a brief summary of his later work for the Report of Progress of the Kentucky Geological Survey for 1910 and 1911, which was published in 1912. In it the term Caseyville conglomerate was changed to Caseyville formation and revised estimates of thickness were given for each of the formations. No other names or limits were changed.

In 1916 the Kentucky Geological Survey, in cooperation with the U. S. Geological Survey, published a report by Wallace Lee on the Kentucky portion of the Shawneetown quadrangle.

In discussing formations Lee objects to the writer's 1910 term Caseyville *conglomerate* as being a misnomer, in as much as

in a measured section of these rocks given by him only about one-third of the Caseyville is really conglomerate. He proposes instead the name Caseyville sandstone, although singularly his own section shows even less sandstone than conglomerate. *Formation* is a better term than either *sandstone* or *conglomerate* and had already been adopted by the present writer in 1911 as has been related above.

Lee says next that he uses Tradewater Formation in the same sense as used by the present writer but makes it clear in his next sentence that he makes its top at the base of the underclay of Owen's coal 5—now called coal 6—instead of about 50 to 75 feet higher at the base of the Sebree sandstone as the writer does. He uses Carbondale as it has been used in Illinois with its upper limits at the top of Kentucky coal number 11, although he recognizes and states that it would perhaps be more logical to include in the Carbondale the rocks on up to the prominent break at the base of the Anvil Rock sandstone. The McLeansboro Formation is used by him for the rocks from the top of coal number 11 to the base of the Dixon sandstone. For the Dixon sandstone and the overlying rocks to the top of the Pennsylvanian Lee proposed the term Henshaw Formation. Since this formation is identical with the Dixon Formation the necessity of thus renaming it is not apparent.

In the present report the writer uses the same formation names and limits as in the Report of Progress in 1912 except that he drops the terms DeKoven and Mulford and adopts Carbondale instead. As here used Carbondale differs slightly in both its upper and lower limits from the term as used in Illinois and by Lee, as cited above, in the Shawneetown report.

The Caseyville and most of the Tradewater formations are included in the Pottsville. The base of Owen's Curlew sandstone is probably at or at least very close to the top of the Pottsville. It is unfortunate that this Curlew sandstone soon loses its identity and hence cannot be used as a formation boundary for mapping purposes. The nearest stratigraphic horizon that may be reorganized all over the country is the Sebree Sandstone. The base of this sandstone marks the top of the Tradewater formation.

Instead of drawing the base of the Carbondale at the base of the underclay of coal number 6 where there is seemingly no stratigraphic break and which cannot be identified at all in the Sebree region with any certainty, much less be followed there as a mappable division line, the writer places the base of the Carbondale slightly higher at the base of the Sebree sandstone where there is an erosional unconformity and a prominent lithologic break and topographic scarp easily recognized and mapped.

Instead of placing the top of the Carbondale, as here used, at the top of coal number 11 of Kentucky (or the number 6 or Herrin coal of Illinois) where there is at most only a slight local unconformity, and where tracing and mapping would be difficult and uncertain where coal number 11 is absent, as in parts of the county about Clay and Sebree, the writer places the top slightly higher at the base of the Anvil Rock sandstone where there is a prominent erosional unconformity and usually a distinct lithological change.

The lower limits of the Carbondale, as here used, are somewhat higher than the base of the Allegheny, but since the base of the Carbondale as used in Illinois is probably also somewhat above the top of the Pottsville according to David White[12], it would seem that the matter of exact age limits should not overbalance lithological changes that furnish practicable means of mapping. It is not certain that the upper limits of the Carbondale, as used in Illinois, are quite up to the top of the Allegheny according to White[13], so that extending the Carbondale slightly higher as is here done may give a closer approximation to the top of the Allegheny as well as furnish a natural, easily recognizable break for a formation boundary.

It may be well here to call attention to the possibility of the upper portion of the Dixon Formation being of Monongahela age. A small collection of fossil plants made from a thin coal just under the Vanderburg sandstone and close beneath the crest of the hill east of Havana creek on the road from Vanderburg to Catesville, was pronounced by David White to be insufficient for definite correlation but to have Monongahela affinities. It might be that the Vanderburg sandstone and Mt. Gilead shales and

[12] Ill. Geol. Surv., Bull. 14, p. 294, 1909.
[13] Ill. Geol. Surv., Bull. 16, p. 179 and p. 289, 1910.

sandstone are of Monongahela age. They are here put as the two upper members of the Dixon Formation and are described on pages 119 to 121.

Since in the preceding formation tables comparisons are often made with Illinois coals it seems wise to give a correlation table for Kentucky and Illinois coals. The writer at first thought of trying to restore Owen's old name of Number 5 to the coal now generally known as number 6 but has concluded to follow current usage and call it number 6 rather than risk the confusion that an attempted change of number would probably cause.

A discussion of the disadvantages and confusion resulting from giving numbers instead of names to coal seams is given on pages 111 to 113.

Table Giving Correlation of Coals in Illinois and Kentucky.

Owen, Ky., 1858	Illinois		Kentucky	
	Nos.	Names	Lee, Shawneetown	This Report
				Polly
			Geiger Lake	Geiger Lake
				Lisman, Belcourt
				14. Baker
				12.
11.	6 & 7	Herrin	Herrin	11.
10.	5½ & 6		Briar Hill	10.
9. Mulford	5	Springfield	Springfield	9.
8. Well	4			8b.
7.				?8a
6. Three-foot	3		DeKoven	7.
5. Four-foot	2	Murphysboro	Davis	6.
4. Curlew			Curlew	
			Smith	
3. Ice House			Ice House	
2.				
1-B. Bell			Bell	
1-A.				
Battery Rock			Battery Rock	
.				

In Indiana coals 5, 6 and 7 are the equivalents of coals 9, 11 and 12, respectively, of Kentucky.

Animal and Plant Fossils.

The correlations of the main divisions of the Pennsylvanian made in preceding pages are based partly on stratigraphic comparisons with Illinois sections and coals but mainly on paleobotanic data secured by Dr. David White in the Illinois coal field, supplemented by some work done by him in the DeKoven region of Union county. No general attempt was made to collect plants during the writer's work in the region. At two places very high in the Pennsylvanian section, however, he found a few poorly preserved plants that were submitted to Mr. White for identification.

The first collection was obtained from shales immediately under and over a thin coal found a mile north of Vanderburg, Kentucky, on the main road to Henderson. The elevation is 460 feet above sea level and 30 feet above the top of the Dixon sandstone. It consists mainly of fragments of *Neuropteris ovata* and *N. Scheuchzeri*. The following is the complete list:

Neuropteris Scheuchzeri.
Annularia sphenophylloides var. *intermedia.*
Pecopteris unita.
Alethopteris Grandini.
Odontopteris cf. *subcuneata* Bunbury?
Neuropteris ovata.

He regarded this collection as suggestive of a level not far above the base of the Conemaugh, or possibly slightly lower.

The second collection was from just beneath a thin coal found four miles east of Dixon on the road to Catesville. It is on the west slope of the hill east of Havana creek at an elevation of 500 feet above sea level and 175 to 200 feet above the top of the Dixon sandstone. It is stratigraphically about 150 to 175 feet higher than the preceding collection. The material is a light buff, somewhat friable, argillaceous shale. The forms are as follows:

Annularia stellata.
Annularia sphenophylloides.
Sphenopteris sp. A small fragrant probably referable to *S. Lescuriana* F. & I. C. W.
Pecopteris (*Asterotheca*) sp. Undeterminable fragments.
Sigillaria mutans, var., a form belonging to the Brairdii group.

While insufficient for correlation purposes the aspect of the types seems to indicate a high stage in the Pennsylvanian and Dr. White was inclined to regard the material as possibly Monongahela in age.

Dr. White was of the further opinion that the basal sandstones of the Pottsville along the western margin of the Western Kentucky coal field, which were laid down during the advance of the Pennsylvanian sea into the region north of the Ohio river, are as old as the Raleigh sandstone of West Virginia, or possibly older; but that evidence was not yet in hand fully to prove it as old as the Sewanee (Bon Air) conglomerate of Tennessee.

At a number of places in and around Webster county marine invertebrates were obtained. These were submitted to Dr. George H. Girty for identification. He has reported on them as follows:

1. *Fulcher and Melton Hills,* two miles southwest of Wanamaker, Webster County, Ky. Material from Leitchfield formation of the Mississippian, as exposed along the Rough creek fault zone.

Productus pileiformis.
Diaphragmus elegans.
Spirifer increbescens.
Composita subquadrata.

2. Several places on the same chert horizon, in the east end and south side of the Sebree Hills, from a fourth of a mile to a mile west of Steamport Ferry. This horizon is in the Tradewater formation below coal number 6, and is Pottsville in age. The forms found are:

Schizophoria resupinata.
Productus aff. *gallatinensis.*
Productus punctatus.
Spirifer cameratus.
Spirifer rockymontanus.
Composita subtilita.
Deltopecten occidentalis?

3. Sullivan, Union County, Ky. In the roof shales over number 6 coal.

Lophophyllum profundum.
Ambocoelia planiconvexa.
Euphemus carbonarius.
Bellerophon harrodi.
Patellostium montfortianum?
Phanerotrema grayvillense.

4. Roof of number 9 coal, from shaft mine at Robard, Henderson County, Ky.

Eupachycrinus tuberculatus.
Derbya crassa.
Chonetes mesolobus.
Lingula umbonata.
Productus cora.
Marginifera muricata.
Composita subtilita.
Astartella gurleyi.
Aviculopecten rectilaterarius.
Pteria acosta?
Euphemus carbonarius.
Bellerophon percarinatus
Phanerotrema grayvillense.
Naticopsis altonensis.
Soleniscus gracilis?
Soleniscus sp.
Orthoceras Knoxense.
Fragments of large *nautiloid.*

5. Providence limestone, rottenstone phase, Clifty Consolidated Mining Company's shaft, 1½ miles south of Clay, Webster County, Ky., just over number 11 coal.

Derbya crassa.
Chonetes mesolobus.
Productus Nebraskensis?
Spirifer cameratus.
Spiriferina Kentuckyensis.
Lima retifera?
Euchondria neglecta.
Deltopecten aff. *occidentalis.*
Nucula anodontoides.
Schizodus sp.

Parallelodon sp.
Pleurophorus subcostatus.
Astartella vera.
Nautilus sp.

6. Providence limestone, two miles north of Providence, Ky., one-half mile south of Lever's mine.

Productus punctatus.
Marginifera splendens.
Squamularia perplexa.
Fusulina cylindrica.

7. Providence limestone, Frank Sanders', two miles west of Sebree, Ky.

Fusulina cylindrica.
Marginifera splendens.
Squamularia perplexa.

8. Gob between number 11 coal and overlying Providence limestone, Thomas mine, Morganfield, Union County, Ky.

Prismopora triangulata.
Chonetes mesolobus var. *decipiens.*

9. Loose material from dump from shaft number 7 mine, West Kentucky Coal Co., north of Clay, Ky., from middle or lower part of Lisman formation.

Crinoidal fragments.
Lophophyllum profundum.
Chonetes mesolobus.
Spirifer cameratus.
Composita subtilita.
Hustedia mormoni.

10. In hill four miles north of Clay, Ky., associated with bony coal, in Lisman formation, near its top.

Cytherella benniei?
Paraparchites beedei?
Carbonia bairdioides?
Rhombopora lepidodendroides.

DETAILED DESCRIPTION OF FORMATIONS.

Mississippian.

Leitchfield.

A series of limestones, sandstones and shales believed to be of Leitchfield age is found at a number of points along the Rough creek anticline just beneath the basal conglomerate of the Coal Measures. Exposures of these rocks are generally poor as they are usually concealed by the surface loam except along chance gullies or an occasional artificial excavation. Their study is further complicated by the fact that as they have been brought to the surface only along the overthrust side of the Rough creek anticline, they stand at almost any angle up to the vertical, change both the angle and direction of dip very materially in short distances, bear evidence of profound crushing and faulting within their mass, may be exposed merely as loose isolated boulders embedded in clay, and nowhere afford continuous sections of any length.

Limestone seems to predominate over shale, while the latter in turn seems to be more abundant than sandstone so far as exposures permit quantitative estimates to be made.

The limestone is mostly dense, fine grained, light gray and compact. Some, however, is more coarsely crystalline and earthy and of a blue color. The finer grained gray variety usually contains few or no fossils while the coarser, darker variety is often abundantly fossiliferous. In some places the limestone is traversed by fine reticulating veins of calcite where it was crushed in the movements that produced the Rough creek anticline but has since been cemented together by calcite as a vein filling.

Some of this limestone, especially the fine grained, compact variety, is cherty. The chert is in small, separate nodules, not in massive layers, and on the solution of the limestone is left in the soil in scattered fragments never over a few inches in diameter and never in such abundance as to affect in any way the use of the land for agriculture.

The sandstone is always medium to fine grained and consists of grains of well washed glassy quartz held together by a ferruginous or siliceous cement. There is little or no mica present. Some of it is in layers from a half inch to 3 inches thick separ-

ated by thin partings of shale, while some is in three to ten inch thick layers without the shale partings. In a few places it is in massive beds, ten or fifteen feet thick. Where thin bedded, the bedding planes may be slickensided from movements along them, and where massive it may be closely jointed from crushing or shearing. This sandstone is unfossiliferous in some places while in others it contains casts of marine invertebrates.

The shales are rarely exposed but where seen are generally greenish or bluish, fine grained, soft clay shales that in some places are calcareous enough to have a marly appearance. At one place in Fulcher and Melton hills an indurated thin sandy shale is found close beneath what was regarded as the base of the Caseyville formation.

None of the surface exposures of the Leitchfield furnish sections of any length that are complete enough to warrant being given here. The best exposures in the county are found in several of the gullies on the north side of the hills one and a half miles southwest of Wanamaker. The gullies on either side of the Harpshead road and for three-fourths of a mile west of it show Leitchfield rocks at intervals. It would seem probable from these exposures that the aggregate thickness of the Leitchfield might easily be four hundred to six hundred feet, though any estimate of thickness made there would be uncertain because of the probability of faulting in the Leitchfield. Just northwest of these surface exposures the deep well on the W. A. Duncan farm penetrated 598 feet of Mississippian rock and ended at the top of a sandstone that may be the Cypress sandstone. If so, these 598 feet may represent Birdsville and Tribune together, or since there seems to have been an overlapping in Mississippian time toward the northeast the Tribune may be absent and the entire section of 598 feet may belong to the Birdsville. This well log is given in full on page 165, but the Mississippian part of it may with advantage be included here.

It is:

Lime and slate 50′	from 1322′ to 1372′
Sandstone 38′	from 1372′ to 1410′
Slate and shells 90′	from 1410′ to 1500′
Black slate 14′	from 1500′ to 1514′

Stray lime 5' ..... from 1514' to 1519'
Slate and shells 401' ..... from 1519' to 1920'
Sandstone, with abudant salt water at ..... 1920'

This churn drill record is subject, of course, to the usual limitation and errors common to such records. It is probable, for example, that the "Slate and shells" is shale interbedded with thin limestone.

On the northern and northeastern slopes of the Fulcher and Melton hills, which lie two miles southeast of Wanamaker, the Leitchfield is again found though the exposures are poor. Fossils are abundant in the limestone found in gullies northeast of the summit of the more easterly of these two hills, while at a limestone spring a fourth mile farther northeast chert and fine grained quartzitic sandstone are found.

Following the Rough creek fault east from the Fulcher and Melton hills the next undoubted Mississippian exposure is found in the small isolated hill immediately east of Knoblick creek on the south side of the road from Wanamaker to Pratt. At the northwest base of this hill a few masses of blue limestone are found. They are much jointed, contain no fossils except an occasional fragment of a small crinoid stem, and dip apparently 52 degrees S. 30 to 35E. Close above this limestone there is a medium fine grained, highly quartose sandstone that has been much crushed, jointed and slickensided and has been so indurated as to look to the eye almost like a quaratzite, though under a hand lens the pore spaces between the glassy grains are largely void and the texture is saccharoidal. The next exposure is some five-eighths of a mile east of Knoblick creek where the road from Wanamaker to Pratt climbs the first hill east of Knoblick creek. At the western base of this hill there are some poor exposures in the road of a fine grained quartzitic sandstone, and in the stream bank a rod or two north of the road exposures are better and show the usual jointing and slickensiding.

Farther east along the Rough creek fault there occurs some much-crushed quartzitic sandstone just west of the prominent bend in the road a mile southeast of Pratt. The exposure is poor but the appearance is very similar to the sandstones of the Leitchfield. The crushed quartzite may be traced southwestward from the above mentioned corner several hundred yards towards the home of Mr. Frank Sanders.

In Sebree 35 or 40 feet of gray limestone is exposed at the rear of the town hall. It is sparingly fossiliferous, cherty and dips 35 to 40 degrees S. 20 E. Other small exposures occur in various town lots to the westward and along the railroad to the south. In excavating the foundation of the present public school building numerous loose pieces of limestone were thrown out. Limestone is reported in the bottom of a stock pond once dug a few hundred yards northwest of the school building, but now so largely filled up and overgrown that the report could not be verified.

Immediately back of the new public school building in Sebree there are on the surface loose pieces of fossiliferous Leitchfield sandstone and these can be traced westward along the crest and north side of the ridge for several hundred yards.

East of Sebree there is a single small exposure of Leitchfield at the foot of one of the spurs that project northward from the main ridge or backbone of the Sebree hills. At the very base of the hill there is a gray limestone once burned for lime and over it and just west of it for a few rods are fragments of jointed, slickensided, fine grained quartzitic sandstone, similar in all respects to that mentioned at other points along the Rough creek fault. The exposure of limestone is only a few square yards in area and is about one mile east of Sebree.

Farther east the line of the Rough creek fault, along which alone the Leitchfield is found in the county, is concealed by the deep alluvial filling of Graves creek and Green river and further exposures of Leitchfield do not occur in the county.

Economic Materials of the Leitchfield. This formation contains the only limestone in the county of sufficient purity for making lime. The exposures of it are so poor, however, that it is doubtful whether any considerable quantity could be quarried at a reasonable cost. The most promising area for a limekiln is that along either side of the Harpshead road on the north slope of the hills east of Jones' stand, or Tilden as the topographic map wrongly calls it. This point is remote from transportation, would have difficulty in getting fuel to burn it and could be used to supply only such quantity of lime as the local community demanded. Exposures of limestone at other points to

the eastward along the Rough creek fault have been described above, any one of which might supply the small local demand for lime if developed.

The marly clay shales of the Leitchfield are probably not suitable for brickmaking and the quartzitic sandstone is too finely jointed, too local in exposure, and probably too high in iron content to be used either as a building stone or a glass sand. It is possible that some of the sandstone of the Leitchfield, where well covered by other rocks, may, under appropriate structural conditions, contain oil or gas.

Pennsylvanian.

CASEYVILLE FORMATION.

Definition. This formation, in the type locality at Caseyville in Union county, where the top of it is well exposed in numerous cliffs in and south of the town, extends from the top of the massive conglomeratic sandstone a few feet beneath Owen's No. 1A coal downward to the top of the limestones of the Mississippian. It forms the base of the coal measures and underlies practically all of Webster county but is exposed at the surface only in certain small areas along the Rough creek fault in the northern part of the county. These exposures will be described in detail on pages 68 to 70.

Character. The formation consists mainly of massive crossbedded sandstone that is usually coarse grained and in many places is conglomeratic. The pebbles are of well-rounded vein quartz and average a half inch or less in diameter. The crossbedding is usually strong and well marked, especially on such exposed surfaces as cliff faces where it has been accentuated by differential weathering. The mass may be firmly cemented by silica or loosely cemented by limonitic iron, which often forms streaks, plates or masses of sand-ironstone. The individual beds are generally massive and vary in thickness in Webster county—so far as scant surface exposures permit of direct examination—from 20 to about 50 feet. The thickness of at least the top sandstone bed is subject to marked variation within short distances. It may be 20 feet thick in one place and in a few hundred yards may thicken to 50 feet or more. It is likely from the variable character of the currents by which the formation was deposited

that similar rapid changes mark the thickness of the individual beds throughout the entire formation. A similar rapid variation characterizes the distribution of pebbles within a given bed. They may either be entirely absent or very abundant and the change from one phase to the other may occur in a few yards. It is probable that the middle and lower part of the formation may locally contain individual beds of considerably greater thickness. The log of the Duncan bore hole near Tilden, for example, gives a solid mass of 227 feet of coarse sandstone. It is entirely possible, however, that there are minor partings of shale in this interval that were not noted by the driller.

NO. 15. TOP OF CASEYVILLE CONGLOMERATE.

A low cliff of massive conglomerate shows through the trees just southeast of Sebree Springs.

Interbedded with the massive conglomeratic sandstone there are at least locally developed shale beds that reach thicknesses of 15 to 30 feet in the few places where it is exposed. These shale beds, in the nearby region south of the Tradewater river, contain coal beds that in a few places are locally thick enough to mine, but have never been found of any considerable extent. In Webster county, the writer has not found any interconglomerate coal and the few drill records in the county that include rocks of this formation make no mention of such find. A thin coal was, however, reported to occur in the shale beneath

the top sandstone some four hundred yards southeast of Sebree Springs in the drain that leads from a prominent spring situated just on the top of the cliff. Talus from the cliff had so choked up the small channel that while some 15 or 20 feet of shale could be seen, no coal was visible when the writer examined the locality. The top of the conglomerate some rods south of this point is shown in plate No. 15.

Thickness. At no point in Webster county can the entire thickness of the Caseyville formation be seen in natural exposure. Its thickness elsewhere in the Tradewater region may be taken at about 200 to 500 feet. The only accessible bore hole record in Webster county that includes it is the Duncan bore at Tilden. It seems most probable that it is the coarse sandstone there recorded as 227 feet thick, although there is the possibility that the 137 feet of "Lime, shells and shale" and the 18 feet of coarse sandstone that overlie the 227 feet should be included with it. The latter supposition is here rejected on the ground partly of the thickening to 382 feet involved but mainly because of the great thickness of the soft material described as "Lime, shells and shale" that would on the rejected alternative be included in the Caseyville formation. At the same time it is recognized that this 155 feet of shale and sandstone, when included in the overlying Tradewater formation, makes it thicker than it is at Sebree to the east. It seems likely, however, that the Tradewater formation thickens from Sebree westward since it is much thicker in the DeKoven region than it is here considered to be at Tilden. Another element of uncertainty in determining the thickness of the Caseyville at Tilden arises from the fact that the variant record of the Duncan farm well log gives beneath the main sandstone—which it makes 235 feet thick—several alternating beds of slate and sandstone down for 184 feet before the first limestone is recorded. It is possible that one or more of these lower sandstones may belong to the Caseyville, though it seems equally possible that they may be in the upper part of the Mississippian where fine grained sandstones are known to occur in this region. Details as to the probable composition of the Mississippian are given on pages 139 and 140.

Divisions. The Caseyville formation is probably nowhere capable of well defined subdivisions and certainly in Webster

county surface exposures are too few and too limited in area to justify any attempt at such subdivisions. There is some evidence, however, that the second sandstone bed from the top of the formation is more ferruginous and more conglomeratic than the top sandstone. The interval between these two sandstones where exposed is some 20 to 40 feet and is occupied by shale.

Economic Materials. The Caseyville formation contains, as stated above, some coals in the region south of Tradewater river that are locally thick enough to mine over small areas. These are, however, so unrealiable that they are at best of only local value. In Webster county there is no direct evidence anywhere of coal in the conglomerate thick enough to mine. Even if such coal were known to exist, the Caseyville conglomerate is so badly faulted and disturbed where it comes to the surface in this county that the coal would be useless, and money spent in its exploration and development would be wasted.

The massive sandstone or conglomerate might be used as rough masonry for bridge piers, foundations, retaining walls and similar structures or might be crushed and used for building sands were there sufficient demand for it. The extensive outcrop at Sebree Springs is immediately adjacent to the Louisville and Nashville Railway and is conveniently situated for quarrying or crushing.

The massive sandstone beds of the Caseyville are porous and make an excellent reservoir for water, oil or gas. Where penetrated by the drill at Tilden and at Sebree on the north side of the Rough creek fault they have been found saturated with salt water. Elsewhere under more favorable structural conditions they might be found to contain oil or gas. It is possible that some such favorable areas may exist in the county on the south side of the Rough creek fault where the Caseyville conglomerate is rising northward toward the fault plane but does not reach the surface before it is broken off and the end sealed up by the fault, as is shown in Plates 27 and 28. The axis of the broad syncline that embraces the larger part of Webster county lies some six to ten miles south of the Rough creek fault and the slope up which oil and gas, if present, would slowly move would consequently be a long one and give a large area from which it would collect. As the minimum dip of the rocks near the fault

is some 15 to 20 degrees and the maximum dip is two or three times as great, if any portion of the Caseyville were saturated with oil, the horizontal or surface extent of the oil bearing area would not be great but would form a narrow belt roughly parallel to the fault.

Occurrence. The Caseyville occurs as a surface formation in Webster only in certain small areas along the Rough creek fault as it crosses the northern part of the county. These areas will be briefly described by taking the successive outcrops in the order of their occurrence west to east along the fault.

The most western occurrence of the Caseyville in Webster county is found one and one-half miles east of Givens on the road to Tilden. The material is a coarse, loosely cemented, ferruginous, cross-bedded conglomerate that has been crushed and slickensided during the faulting that raised it to its present position. It is poorly exposed on the low wooded hillside from near the highway some rods northward to the crest of the hill as is indicated on the geological map. The hill really rises a hundred feet above the roadway instead of less than twenty feet as the contours would indicate. The amount of the dip could not be determined with any certainty but its direction was south 15° to 20° west. The length of the area within which congolomeratic exposures occur is 350 or 400 feet. These exposures project but slightly thru the blanket of yellow loam that overspreads the hill.

The next exposure is larger and more prominent topographically and is found southeast of Tilden in the line of hills between there and the Harpshead road. The crest and part of the upper slopes of these hills are composed of massive conglomerate that is firmly cemented and resistant to erosion. Dips are quite variable, ranging in amount up to 50 degrees and in direction from S. to S 42 W. There is much crushing and slickensiding and at the east end of the hills, a few rods west of Harpshead road, there is a small crushed area in which blocks of conglomerate and Mississippian limestone are indiscriminately intermingled.

The next area of conglomerate is found in the Fulcher and Melton Hills one and a half miles southeast of Wanamaker. Exposures on the northwest knob are exceedingly poor but in a

large ravine about midway of the length of the hills, on the north side, there are good exposures that may be readily traced to the southeastward to the other knob whose crest and northern, eastern and southeastern slopes contain abundant boulders of the usual ferruginous, pebbly, cross-bedded type. As on the Tilden hills, dip and strike vary greatly and in many places are difficult to obtain with any high degree of certainty.

To the eastward no more exposures of the Caseyville occur until one approaches Sebree. A mile southeast of Pratt loose conglomerate shows on the south side of the hill on which the road to Sebree turns eastward and following the road toward Sebree conglomerate is found on the north side of the road exposed at intervals in the hill top from a half mile west of town eastward to the new public school building. East of there the conglomerate is not again found in the county along the immediate line of the fault, but just south of Sebree the rocks have been arched into a domed anticline by the pressure that caused the Rough creek faulting. Erosion has unroofed this dome so that the upper part of the Caseyville is admirably exposed at and south of Sebree Springs.

NO. 16. CLIFFS ALONG FORMER STREAM CHANNEL.

This abandoned stream channel just south of Sebree was once occupied by Deer Creek. Its bottom is broad and flat and cliffs of Caseyville conglomerate bound its sides.

At Sebree Springs there is a narrow defile once occupied by Deer creek but now occupied only by the railroad that finds it an admirable passage way thru the Sebree hills. This defile is flanked on either side with vertical cliffs of Caseyville conglomerate. About the Springs the material is at top a loosely cemented sandstone 20 to 30 feet thick that weathers into undercut, cave-like recesses or rock shelters. A fourth mile to the south this top bed thickens to 40 or 50 feet and becomes pebbly and more massive. The massive cliff-forming stratum is so well exposed in the region just south of the Springs that its domed structure may be readily determined from the altitude of the outcrops. The boldest cliffs are some 40 or 50 feet high and are found on the north side of an isolated area about two-fifths of a mile south of the Springs. The underlying shale bed mentioned above is, however, not exposed at this point.

Beneath this massive top bed some 15 or 20 feet of shale are visible along a small spring branch about four hundred yards southeast of Sebree Springs, mention of which has been made on page 66 in discusing possible coal beds in the Caseyville.

Except for the few small areas described on previous pages in which rocks of Mississippian age occur at the surface, the entire area of the county is underlaid by the rocks of the Caseyville formation. We have seen that the area of outcrop is confined to the vicinity of the Rough creek fault. Away from this fault the Caseyville forms the floor, as it were, on which the coal-bearing rocks rest. North of the fault it would be reached by borings at a depth of 800 to 1,200 feet. South of the fault its depth beneath the surface varies from 0 to 2,500 or 3,000 feet along the axis of the synclinal trough that passes thru the Dixon-Vanderburg-Mt. Gilead school region. Southwest of this line the conglomerate rises gradually until on the southwestern side of the county along the Tradewater river it is only some 350 to 625 feet beneath the surface.

Tradewater Formation.

Definition. This formation extends from the top of the Caseyville formation upward to the base of a prominent scarp-making sandstone that in the southwestern part of the county forms a scarp line that overlooks the Tradewater valley from Sullivan to Yarbro and in the northeastern part of the county

caps most of the range of high hills east and west of Sebree. In this latter region it is seen in its best development in the cliffs that generally form the edge of the flat topped ridge that extends from Sebree east to Green river. It has been called by the writer the Sebree sandstone.

Thickness. The thickness of the Tradewater formation varies greatly within the confines of the county. The minimum known thickness is in the northeastern part of the county where it varies from 175 to 195 feet. At Sebree it is 181 feet in one boring and 186 feet in another. It thickens to the westward and in the Duncan well at Tilden whose record is given on page 165, it is—according to the interpretation here placed on that record —345 feet thick. Between Caseyville and DeKoven in Union county is 624 feet thick in surface exposure and at Grangertown in the same county it is 693 feet in a bore hole whose log is included in the general section in Plate 4. This would indicate some thickening to the southwest so that it is likely that in southwestern Webster county it exceeds 700 feet in thickness.

Character. The formation is composed chiefly of shales most of which are sandy. Those near the base are, in addition, micaceous in the Tradewater region and from their peculiar dark gray color and luster have been called by Owen "Gunmetal" shales. These shales are generally gray, blue or light green in color when fresh but weather almost uniformly to a yellow or rusty color. At a number of horizons they are carbonaceous and are either dark brown or black. Such dark shales are usually very fissile, are not over 2 or 3 feet thick, and may be associated with either coal or limestone or may be imbedded among other shales.

Sandstone forms a subordinate part of the formation and is more prominent in the lower than in the upper part. In both parts it is medium to fine-grained and often inclined to be shaly. In the upper part of the formation the sandstone layers are generally thin but in the lower part there are in the Caseyville-DeKoven region two prominent sandstones, each 20 to 50 feet thick and known as the Finnie and Curlew. They vary greatly in character and thickness in short distances and have lost their prominence, if not even their identity, before reaching southwestern Webster county.

Besides the shales and the sandstones the formation contains some very thin earthy limestones, two thin chert horizons, and a number of coals, most of which are also thin, local and highly variable.

The limestones of the formation vary from a few inches to three or four feet in thickness and except at one horizon rarely show in surface exposure. They are highly argillaceous and either compact or brecciated. They may or may not be fossiliferous. At two horizons they are cherty and usually the only surface indication of their existence is the presence of broken chert.

The most prominent limestone of the formation in the De-Koven region is the Curlew. In its type locality there in Indian hill two beds are visible each one to two feet thick, and separated by 15 feet of shale. The upper bed is some 25 feet beneath the base of the Curlew sandstone and in this interval Owen's coal 4 occurs. A fourth of a mile east of Indian hill three limestones show in a small ravine which gives the following section:

Limestone, seen in loose flat pieces only, probably	1′ to 2′
Coal, once dug into, probably coal 4	
Shale	8′
Fire clay probably	1′ to 2′
Shale	22′
Limestone, massive	2′ to 2′ 6″
Shale, light colored, argillaceous	14′
Iron carbonate	0′ 4″
Sandy shale	5′
Fossiliferous limestone, ferruginous	3′ 6″ to 4′
Shale	4′

In bore 15 of the West Kentucky Coal Co., near Grangertown in Union county limestone beds from 6″ to 3′ in thickness occur at 140, 143, 177, 207, 307, 326 and 497 feet below the top of the formation. It is probable that the Curlew horizon includes the beds at the 177 and 207 foot horizons. On going southeast from Grangertown into Webster county direct surface tracing is impossible and deep well records do not exist so that correlation must be made on other grounds. In the Blackford region no limestones were found save an isolated boulder at the road corner a mile northwest of Derby. No other occurrences were noted until Montezuma Ford is reached where a fossilifer-

ous chert is found near the top of the low bluff and may be traced along the crest and western slope of the ridge for a mile to the southeast where 4 to 6 feet of dark brecciated, cherty, fossiliferous limestone is exposed in a number of places near the home of E. F. Shelton. The section there is as follows:

Soft sandstone	15′
Thin coal bloom, say	0′ 3″
Dark clay shale	15′
Brecciated cherty limstone	4′ to 6′
Dark clay shale	5′ to 7′
Coal, bony	0′ 9″
Gray clay	0′ ¾″
Coal, bony	1′ 1″
Thin carbonaceous shale with rotten or macerated plant remains	1′ 6″
Under clay	1′ 6″

Attempts have been made at several places to open this coal but it was found bony and not over 18 to 20 inches in thickness. The uninitiated should be cautioned not to confuse this coal and the overlying limestone with coal 11 and the overlying Providence limestone. A few feet beneath the coal there is a massive soft sandstone only the upper 15 to 20 feet of which shows at Montezuma Ford and near Shelton's, but some two miles south of Shelton's in Crittenden county this sandstone is 30 feet thick a short distance north of Hood's School house and has a cherty limestone close above and another just below it. The sandstone is probably at or near the Curlew horizon and the cherty limestone above it would be correlated with the limestones close above what is taken for the Curlew sandstone in the Grangertown bore hole, a log of which is given in the writer's Report on a Reconnaissance of the Tradewater River Region.

To the southeast in Hopkins county this chert is well developed near Tweddleville, Dalton, Kirkwood Springs and Beulah.

In the northeastern part of Webster county where the Tradewater formation again outcrops, as will be seen from the paragraph below on the distribution of the formation, a cherty fossiliferous limestone also occurs at possibly the same horizon as that in the Montezuma Ford region. It may be seen a few hundred yards northwest of Steamport Ferry (locality 1). A mile

west of there near Ashby's quarry it occurs just north of the Sebree road (locality 2). It is found on a small isolated hill a mile southwest of Sebree Springs (locality 3) and again at several places in the lower slopes of the high hills two miles southwest of Sebree.

At localities 4, 5, 6, and 7 southwest of Sebree a sandy mud stone occurs in the Tradewater formation with casts of vertical tubes probably not of worms but of fucoid stems and curved, plume-like impressions of fucoid fronds of *cauda-galli* type. Such fucoids are rare anywhere in the Pennsylvanian and have been found by the author in the Tradewater region only at Caseyville, Dawson Springs and near Sebree. The best specimens were found at locality 8 a mile south of Bald Knob. All of these occurrences are in the lower part of the Tradewater formation. Those near Sebree are at the same horizon but whether those at Caseyville and Dawson Springs are also at the same horizon cannot be definitely stated.

Near Sebree the fucoid horizon in some places contains clay instead of mudstone or sandstone and is then filled with stigmaria instead of fucoids. At locality 7 four feet beneath the fucoidal sandstone there is a foot of fossiliferous limestone.

These fucoids and cherty limestones were found to be valuable aids, especially in the Sebree region, in tracing horizons and determining structure and probably will be equally or even more valuable in other parts of the coal field where extensive faulting or other disturbances occur, or where surface loam largely conceals the underlying rocks.

At numerous horizons in the Tradewater formation there are soft clays usually associated with thin coals as underclays, though at some places occurring with a thin limestone. It is likely that some of these should be classed as fireclays. The thickest as well as one of the most persistent and uniform of these clays is the one under Owen's coal 6 —now generally known in southwestern Webster as coal 7. It is usually not over 20 feet beneath the base of the scarp-forming Sebree sandstone that everywhere overlies and marks the top of the Tradewater formation. This clay is 4 to 6 feet thick, light gray in color, highly siliceous, and filled with the impressions of small strap-shaped plants or plant rootlets.

This clay horizon crossess southwestern Webster from Sullivan to Belleville so close beneath the top of the formation that this line may be taken as practically the outcrop of the clay and so may be used as a guide in locating it.

Coal beds form another constituent of the Tradewater formation. In the deep well at Grangertown 18 or more coals were found in this formation and beneath them there is at least one more coal, 1A of Owen. Most of these coals are very thin and of no present or even remote economic value. As a rule they are not persistent and but few of them can be traced for any considerable distance with very much certainty.

To the first or lowest three of these coals Owen gave the numbers 1A, 1B and 1C and to certain of the other more prominent ones in the Caseyville-DeKoven region he gave the numbers 2 to 6 inclusive. Of these only Owen's coal 1B, now generally known as the Cook, or Bell coal, and his coal 5—now universally called coal 6 in the Tradewater river region—are of economic importance. Their position and outcrop will be given here and their character and value in the following pages.

Coal 1B does not outcrop in southwestern Webster but lies at least in the Blackford region, at no great depth. In the Sebree region it is not known to exist at all. Coal 6, or coal 5 of Owen, occurs from 60 to 120 feet beneath the top of the formation in southwestern Webster. Its outcrop is near the base of the line of steep hills that extend from Sullivan to Yarbro and is marked by a row of country openings for practically all of this distance. In the Sebree region coal 6 is not identified with certainty. It is very probably absent in most places but may be represented in others by a few inches of smut or coal with accompanying underclay about 40 feet beneath the base of the Sebree sandstone. A coal 8 to 10 inches thick occurs 40 feet below the base of the Sebree sandstone in a shaft sunk by J. M. Ashby two miles southeast of Sebree at locality 9, that is most probably coal 6 and is the best showing of this coal known in the Sebree area.

Above coal 6 there is developed in both the Tradewater river and the Sebree area a coal called by Owen No. 6, though now generally known as No. 7. This coal lies close beneath the top of the Tradewater formation and may be seen in numerous places in natural exposure. It is exceedingly variable and is generally

valueless though many attempts have been made to open it and in a few places it has in the past furnished some coal for local use though at no place is it mined today and in only one or two places could these old openings be entered.

Southwest and west of Providence where most of these old openings exist, black shale is generally prominent both over and in the coal and in some places the horizon is marked by black shale alone. The coal is apt to have in it in this same region small sandstone masses either as narrow vertical dykes or as horizontal masses up to 6 by 12 inches in cross section and of indefinite length filling old rill channels, apparently, in the coal. One of the best exposures is found in N. B. Smith's opening at locality 13 where the section is as follows:

Massive Sebree sandstone	10′
Concealed	6′
Shale, thin, gray	3′
Shale, gray-black, part thin sheety or papery, highly pyritic	4′
Coal, bony, with sandstone masses up to 6 by 12 inches in cross section	2′ 3″
Clay, dark gray	0′ 2″
Coal, bony, with thin streaks of black shale	1′ 0″
Shale, dark, soft, with thin streaks of coal in upper half	2′ 1″
Bone	0′ 6″
Underclay, gray, with plant impressions	3′ 0″

A half-mile to the southeast the horizon of this coal number 7 is represented by massive black shale 4 to 6 feet thick and cut by "horses" or vertical fissures filled with sandstone or clay. About Green Grove church it has been opened in several places close beneath the Sebree sandstone. Just north of there the Sebree sandstone cuts down across the intervening shales until it rests practically on top of the coal which there is thinner but cleaner and better than in the Smith opening given above. A good natural exposure is seen in the road that climbs to the top of the escarpment a mile southeast of Hopewell church, where 20 inches of thin carbonaceous shale overlie 7 inches of coal, beneath which there is a highly siliceous gray underclay filled with impressions of small plant rootlets.

In the Sebree region also coal No. 7 is likewise found close beneath the base of the Sebree sandstone. Just east of Sebree

it shows 12 inches of coal. Two miles southwest of town it was once opened at a number of points around the east end of the hill at locality 15 and considerable coal was taken out. It is reported to have been between two and three feet thick there. On the north side of the high area west of Knoblick creek, what is apparently the same coal was formerly opened in several places and some coal was taken out for local use. All of these openings are abandoned and closed so that it was impossible to obtain a section at any of them. The gray siliceous underclay that characterizes this coal near Sebree with its impressions of plant rootlets is very similar to that found in similar position under coal 7 in southwestern Webster and the two coals are undoubtedly to be correlated as the same and the equivalent of coal 6 of Owen. From what has been said it is evident that this coal is not of present value. The siliceous underclay may, however, prove of value as a fire clay and in that event it might be desirable to mine coal and clay together in the Sebree region. It is probable that the coal there would furnish an ample supply of fuel to grind and burn the clay.

Economic Materials. Coal is the chief economic material in the Tradewater formation. It may occur in workable thickness and quality at two horizons, as stated on a preceding page, though there is considerable uncertainty as to the value of the lower of these known as the 1B, or Bell, coal. In Union county this Bell coal may be traced up the Tradewater river to a point about a mile and a half above Smallwood Ford. Across the river in Crittenden county it may be traced up stream to within a mile of Perry Ford, a number of old openings being found along the river at the base of Snead hill where it shows 36 inches in one and 38 inches in another of these old openings. In each case it is good, clean and solid and at each place was mined years ago. Three miles southeast of these openings in Snead hill a coal was once opened on the south side of Hood's creek about one mile southwest of Blackford that cannot be far from the Bell coal horizon if, indeed, it is not the Bell coal. It is there a very impure bony coal with much heavy black shale and is worthless. To settle the identity of this Hood's creek coal detailed tracing in Crittenden county would be nec-

essary. In the absence of such tracing the author feels safe in saying that the Bell coal has either changed to this bony coal or has become thin and inconspicuous, or has disappeared entirely.

It becomes a problem then whether it also thins to the east and is useless in the county north and east of Blackford or not. This could be determined only by drilling and with coals 9 and 11 and the Baker coal accessible over large areas there is no incentive to drill for a 36 inch coal even if the quality were as good as it is known to be in places near the mouth of the Tradewater. That is to say the Bell coal is of very hypothetical value in southwestern Webster today.

Coal 6 outcrops near the base of the high bluffs that run in a line from Sullivan in Union county southeastward to Yarbro in Hopkins. It is mined at a number of places along its crop for country use. Near Golds it was long mined. One place there has recently been reopened by Wm. Silvey at locality 92. Southeast of there it is now mined by Vaughan and Nesbitt at locality 10, by R. Curry at locality 11, and by A. A. Teague at locality 12, and in former times was mined at numerous other old openings, the most southerly of which in this county is the old Trabue mine on the bank of the Tradewater river 400 yards above the bridge at Belleville.

The coal is in a shale interval of some length, the part below the coal generally not being well exposed but the shale over it being 40 to 60 feet thick and weathering to a rusty color. The coal itself runs in the mines mentioned above from 46 to 50 inches in thickness with an average that is probably slightly under 48 inches. The only parting or impurity is a thin sulphur band that will run from a knife edge to an inch in thickness and occurs usually within from 6 to 10 inches of the bottom of the coal. It is usually though not always present. Immediately over the coal there is always a 3 to 8 inch layer of highly ferruginous argillaceous limestone filled with marine fossils either entire or in fragments. The fossiliferous band rapidly disintegrates on exposure and yields an abundant marine fauna. Above the fossil band there are 3 to 6 feet of black shale that forms a good roof. The floor consists of a foot or two of gray underclay that is hard when dry but softens under water.

The coal itself is of medium hardness and has a prominently developed jointing that prevents it from stocking as well as it otherwise would. It has numerous thin layers of mother-of-coal and splits easily along these as parting planes. Sulphur balls or binders are rare in the coal and the roof is generally smooth, though at rare intervals lenticular concretionary masses of pyrite or iron carbonate, a foot or two in diameter and commonly known as "niggerheads," are found projecting down from the roof into the top of the coal.

The general features of this number 6 coal give it a superficial resemblance to number 9 coal. Each is in a shale interval, each has a black shale roof with marine fossils and occasional niggerheads in the roof, and each coal is without parting. In southwestern Webster county the line of outcrop of each coal is so distinct and regular and so well known that there is no reason in that region for confusing the two. In the Marksville-Sebree region, however, and in the faulted region to the southeast in Hopkins county there is need for their careful discrimination. Coal 6 differs from coal 9 in the topography of its outcrop in that the former crops near the base of a steep hill that is capped by the scarp-making Sebree sandstone while coal 9 does not. Coal 6 is rarely or never quite so thick as coal 9. The marine fossils over coal 6 are not in the black shale, as they are over coal 9, but in a calcareous band beneath the black shale, that is hard and gray when fresh but crumbling and rusty when weathered. The fossils over coal 9 are merely flattened impressions while over coal 6 they retain their proper shape and are of calcium carbonate. Niggerheads are rare and small over coal 6 but are common and frequently large over coal 9. Mother-of-coal is more abundant in coal 6 than in coal 9 and a thin sulphur band is often found in the lower foot of coal 6 while sulphur if present at all in the basal part of coal 9 is usually in vertical binders.

In the Marksville-Sebree region the identification of coal 9 was made partly by the above criteria and partly by the presence in a portion of that area of the limestone overlying coal 11, with its distinctive fusulinas. Later it was found that coal 6 in the Sebree region is very thin or non-existent and has no economic value.

In southwestern Webster coal 6 may be conveniently reached by spur tracks from either the Illinois Central or the Louisville and Nashville railroads, and could be developed at any point along its outcrop. It would also be reached by shaft near either railway. The dip is there to the northeast at very nearly 100 feet to the mile and the coal would doubtless be found to hold its thickness of 46 or 48 inches as far down the dip as it would be possible to mine it from the outcrop or reach it under present conditions by shaft.

Samples of coal 6 could be obtained for analysis from only two of the few mines in the county. The results are as given on pages 177 and 178.

These two analyses are closely accordant one with the other. By comparison with the analyses of number 9 coal it will be seen that the two seams have very nearly the same average composition and quality.

From what has been said of coal 7 it is evident that it cannot be considered of economic value save, possibly, in the Sebree region in connection with the underlying clay, and so will require no further discussion. None of the other coals between number 1 and number 6 are of economic value.

The sandstones of the Tradewater formation are not used economically except at a point two miles southeast of Sebree on the road to Steamport ferry where J. M. Ashby has a quarry in a medium to fine grained, light colored sandstone 8 feet thick, the top part of which is pierced with fine vertical tubes like scolithus borings or casts of fucoid stems. The entire sandstone bed has much the appearance of ganister. Rock from there is said to stand well in foundations for houses or chimneys and to resist heat well. Only the immediate community's needs are supplied. Elsewhere the sandstones of the formation are generally somewhat shaly and are rarely used for any purpose.

The limestones of the formation are thin and impure and of no value economically. The shales are abundant and the less sandy ones might be used for brick and tile making were there any demand for them. Occasionally one finds a band of nodules or a thin layer of iron carbonate but it is never in sufficient quantity to be of any value as an ore. The underclay of coal 7,

mention of which was made when discussing that coal on page 76 may prove to be of value as a fireclay. It seems to be present over a wide area and ranges from 2 to 5 feet in thickness.

Areal Distribution. The Tradewater formation occurs, as may be seen by reference to the accompanying geological map, in two areas in the county. The largest of these is in the southwestern part of the county and occupies the Tradewater lowland and extends to the east up the steep slope or face of the bounding escarpment to the base of the Sebree sandstone. The width of this belt in the county varies greatly because of the meanders of the Tradewater river. Much the largest area is near Blackford, but the best exposures for study are found in the vicinity of Montezuma Ford and Belleville. To the northeast it dips beneath later formations and disappears in the broad syncline that occupies the middle portion of the county as we shall see in discussing structure on page 125.

On the northeastern side of this syncline the Tradewater formation again rises to the surface and outcrops in a narrow area of quite irregular outline, as may be seen from the geological map, lying between Marksville and Steamport ferry. This outcrop owes its existence and irregular shape to the manner in which an elongated dome has been unroofed by erosion. On the north the Rough creek fault delimits the outcrop in places, while to the southwest and to the south the formation dips rapidly into the synclinal basin and disappears beneath later formations. Exposures in the Sebree region are generally poor. The upper part of the formation is fairly well exposed at places close beneath the overlying Sebree sandstone, while the lower part in other places is poorly exposed close above the underlying conglomerate forming the top of the Caseyville formation. In southwestern Webster the formation is 700 feet or more in thickness; about Sebree it is greatly thinned and hardly reaches 200 feet in thickness.

Carbondale Formation.

Definition. This formation lies between the Tradewater Formation below and the Lisman Formation above, or it extends in most of the region upward from the base of the Sebree sandstone to the base of a prominent sandstone called by Owen the

Anvil Rock sandstone. In a part of the county centering about Clay this Anvil Rock sandstone is locally absent and there the top of the Carbondale is formed by the lowest beds of a series of marls and limestones that belong to the overlying Lisman Formation. These marls begin close above coal 12 if it is present, or close below coal 14 where it is present.

The name Carbondale has been used by the Illinois and U. S. Geological Survey for some years and is here adopted to replace the DeKoven and Mulford formations, which have been used heretofore by the author for these rocks. The use of DeKoven and Mulford have the advantage of showing as a formation boundary the outcrop of number 9 coal, the most important coal in the county and of recognizing at the horizon of this same coal a minor unconformity, that is best seen about Clay. By combining the two, however, a unit of better thickness for mapping purposes is obtained. The location of number 9 coal is indicated by an outcrop line, as is also that of number 11 coal. Where the latter is absent or thin the outcrop line on the accompanying map is broken.

Thickness. The formation varies in thickness from about 250 feet in the southwestern part of the county to a possible maximum of about 650 feet in the northwestern part.

There is no known direct measure of the entire thickness of the formation in southwestern Webster county. Deep wells and bore holes generally go through only the upper part down to number 9 coal. No well in this part of the county goes through the lower part but in the hole at Grangertown just a few miles west of the line, from coal 9 down to the base of the formation is 108 feet and surface sections in Webster county west of Wheatcroft yield by calculation about the same results. The part from number 9 coal to the top of the formation about Wheatcroft is 130 to 150 feet thick.

About Clay the lower part thickens slightly while the upper part thins somewhat. Surface sections and well logs combined give a total thickness between Clay and Providence of about 230 feet only. About Providence there is a rapid thickening of the upper part from 100 feet to 250 feet in the vicinity of the Webster County Mining Company's shaft and eastward from there toward the Shamrock mines. The lower part is about 130

feet there, so that the total thickness at Providence is about 380 feet. At Sebree the thickness is 307 feet as the log of the well drilled in 1904 is interpreted. In the Duncan bore hole at Tilden, the formation is considered to be 563 feet thick, the part below coal number 9 being 398 feet thick and that above it 165 feet thick.

It is thus seen that the lower part of the formation is rather uniformly between 100 and 150 feet thick except in the well record at Tilden where it swells to nearly 400 feet in thickness. This great increase in the Tilden well raises the question whether this well record may not be wrongly interpreted, so as to give to this lower part (below coal 9) a greater thickness than really belongs to it. As one traces the surface outcrop of the formation from just south of Sebree westward along the southern side of the Sebree anticline the thickness remains about uniform until the vicinity of Ortiz is reached and then a rapid thickening of the lower part of the formation begins and continues for a mile westward to where the formation rounds the end of the pitching anticline and disappears beneath the next higher formation. This thickening gives confidence in the interpretation made of the record of the Duncan well which is some five miles northwest of where the Carbondale formation disappears north of Marksville.

Character. The formation consists of shales, sandstones, coals and limestone. The formation outcrops in two areas, one in the southwestern part of the county in the Wheatcroft-Providence region, the other in the northeastern part in the Sebree-Marksville region. In both areas the base of the formation is a prominent scarp-making sandstone here called the Sebree sandstone. From its topographic prominence it serves as an important stratigraphic and economic guide and will be described at some length on page 97.

Since the formation differs somewhat in certain details in the two areas of occurrence, these will be described separately.

In the southwestern part of the county over the Sebree sandstone there are some ten to twenty or thirty feet of soft yellow clay shale in which are generally found several thin layers of very hard, highly siliceous, fine grained sandstone, each separated from the next layer by a few inches or a few feet of soft shale. Individual beds range from 4 to 10 inches in thick-

ness and have surfaces that, taken in a broad sense, are notably parallel but in detail may be either perfectly smooth or may have rippling or irregular pittings and projections that reproduce the detailed trails and other minor irregularities in the surface of the mud in which they were imbedded.

Above this shale a thin coal occurs that has been called by Owen coal 8a. It is not often seen in good natural exposure and being of no economic value has not been opened except in rare cases where farmers have dug in far enough to determine its character. The best exposure of this coal seen by the writer is in the road a third of a mile west of Ruff at locality 15. It is as follows:

Shale, very dark, thin, rotten, papery, grading upward into lighter colored clay shale	4′
Coal, dirty	2′
Gray clay	0′ 1″
Brown-black carbonaceous shale	0′ 8″
Under clay	1′ 6″

Above coal 8a there are usually 20 to 25 feet of soft shale. This is overlaid by 5 to 10 feet of sandstone that in some places is shaly but in others is very hard and fine grained and has the appearance of a ganister. Over it there are some 2 or 3 feet of underclay, above which comes coal 8b.

This coal, like 8a, is not of economic value and is not usually seen exposed in Webster county though by its strong development of black shale it becomes more prominent—though equally worthless—to the southeast in Hopkins county. It is well exposed in the Louisville and Nashville railway cut at Ruff where the section is as follows:

Thin black shale	1′ 0″
Massive slabby black shale	1′ 4″
Thin black shale	0′ 7″
Coal, soft, blocky, clean, good	0′ 6″
Soft, thin carbonaceous shale, or rash	0′ 2″
Coal, good	0′ 2″
Underclay, sandy, gray	3′ 0″

In the thin black shale poorly preserved marcasitic marine fossils are found. In the heavy, sheety or slabby shale there are carbonized impressions of large strap-shaped leaves.

Above coal 8b there are 30 to 40 feet of soft shale, dark gray when fresh but rusty when weathered. The upper part of it may become very sandy and pass into 5 or 10 feet of shaly sandstone above which are a few feet of soft shale also gray or rusty, up to the underclay of coal 9.

Coal number 9 is a solid coal usually very uniformly about 4′ 8″ to 4′ 10″ in thickness and, except for a restricted area in the nighborhood of Clay where it was cut out by erosion shortly after its original deposition,—as will be somewhat fully discussed in connection with the overlying sandstone that fills the eroded space,—coal 9 is remarkably regular in its presence and thickness, and is rightly counted the most reliable coal in the western field. At no point in the county except about Clay and, possibly, Wheatcroft is it known to be absent, and its absence here is confined to a very restricted area so far as data on the matter can be obtained.

Two miles west of Wheatcroft and just east of the Union county line McGraw, Wallace and Curry each have country openings on number 9 coal at locations 47, 90, and 49, respectively, of the map. It has its usual character. At J. I. McGraw's it is 4′6″; at S. W. T. Wallace's, 4′7″; and at E. Curry's 4′ 6″, all solid and all slightly under the average thickness. South of Wheatcroft it is not opened and little or no information could be gotten concerning it. It may be cut out in that area, since a mile southwest of Wheatcroft in the vicinity of Bob Wells' it was partly or entirely cut out so far as could be learned from several rather poor exposures of its horizon.

Local Absence of Coal No. 9. Just over number 9 coal there are usually 30 to 40 feet of argillaceous shales that may be seen in numerous excellent exposures to the south and west of Wheatcroft and Clay and in many places about Providence. When fresh this shale is usually dark gray but on weathering becomes rusty yellow.

Above this 30 to 40 feet of clay shale there is usually a soft sandstone that is in some places shaly and inconspicuous but in the Wheatcroft-Clay region becomes massive and forms cliffs 15 to 30 feet high. This sandstone, where well developed, cuts unconformably across the shale beneath it and may even cut down entirely thru this shale and rest on or cut into number 9 coal

in the Clay region. At the mouth of the Fairmont mine 1½ miles southwest of Clay at locality 48 this sandstone is 15 or 20 feet thick and is 30 feet above the coal. A third of a mile to the southeast it cuts down across the shales so as to rest practically on the coal at the A. J. Johnson opening at locality 45. In the Fairmont mine the sandstone cuts out the coal entirely and fills a channel some 50 or 75 yards across at a point some 1,400 feet from the mouth of the mine. Beyond this channel, drill records show the coal to be present again in normal thickness.

Two miles northeast of Fairmont in the town of Clay the old Blackwell shaft was sunk to coal 9 but the attempt to mine it was abandoned after considerable difficulty had been experienced because of "faults" struck on either side of the shaft. There seem to be no maps of the mine in existence and the accounts given of the nature of the difficulties encountered are not clear enough to make it certain that they were really due to faults. It seems possible or even probable that they were due to local channels cut thru the coal and filled with sandstone like the one in the Fairmont mine. If so, their width and direction might have been ascertained by some careful drilling and the mine saved to the owners. It seems probable that at Clay an old river or estuary channel cut thru coal 9 making a gap of 50 or 75 yards in width in which no coal is found. The direction of this old channel would seem to be roughly a northeast-southwest line passing thru Clay. How far it extends to the northeast there is no way of knowing short of drilling.

One account, however, given to the writer would indicate that the coal in the old Blackwell shaft was not simply cut out by subsequent erosion as supposed above but was faulted. According to this account no coal was found at the bottom of the shaft at 245 feet depth but was found by driving 23 feet east and also by driving 80 feet south. At 50 feet east and again at 350 feet south of the shaft it was stated that a fault was encountered with a downthrow of about 50 feet to the south on a fault plane of about 45° dip, the course of the fault being reported as northeast. A drill hole 100 feet north of the shaft is said to have indicated another fault with 12 feet downthrow. Surface exposures are too poor to show this faulting even if it exists and no records are obtainable to definitely determine the

matter. A shaft sunk in the eastern edge of Clay at locality 17, known as the Korf shaft, stopped at a depth of 165 feet and a drill hole was sunk in the bottom of it to a total depth of 295 feet from the surface without striking coal. It was taken by some to mean that coal 9 was absent there but in reality the drill had not gone down to the horizon of coal 9 and hence proves nothing as to its presence or absence. Number 9 coal should be reached at the Korf shaft at a farther depth of about 60 feet if the dip is regular from the outcrop near Fairmont.

About a mile east of the Korf shaft the D. D. Baker bore hole at locality 18, was sunk to a reported depth of between 400 and 500 feet and went thru a coal in the lower part of the bore reported to be four and a half feet thick. No log of the well or other very accurate information concerning it has been obtainable. It seems probable that the well was not deep enough to reach number 9 coal whose calculated depth beneath the surface there is between 500 and 600 feet. The coal reported in the lower part of the hole was probably the Baker coal.

While work on the region about Clay was in progress the Clifty Consolidated Coal Company put down several test holes just southwest of the corporate limits of Clay and obtained number 9 coal at the proper depth and of the usual thickness.

Just southeast of Clay and south of Craborchard creek the various bore holes of the Blackwell Coal Company found coal 9 of normal thickness where not cut out and replaced by pond filling. They opened a shaft mine on it there that was later bought by the Clifty Consolidated Company who now operate it. In developing this mine to the west, in attempting to pass under some narrow surface flats that ran back into some little ravines it was a surprise to find that the ravines had once cut down very sharply and even back practically to their heads and had cut out the coal. Before attempting to mine any coal whose horizon was not over 100 to 150 feet beneath the flat surface of the former ponded and filled areas, it is very essential to drill the area to see if the coal is present and what thickness of roof it may have up to the bottom of the Pleistocene filling. This filling consists of soft mucky clay and sand that might flood a mine or give much trouble if the roof were to break and cave up to it.

NO. 17. LOADING PLAFORM FOR WAGON MINES.

Such platforms are cheaply and quickly built and serve for shipping coal when prices are high.

Just northeast and east of Oyama number 9 coal is of normal thickness and is worked by some half dozen small wagon mines and loaded into railway cars direct from the wagons. A view of such a loading platform may be seen in plate No. 17. In such mines the investment is small, the expense of wagon hauling and loading is high and they only operate when demand is brisk and prices good. The stimulus of high prices during and for a time after the world war caused many such small wagon mines to open up. The depression in more recent days has likewise caused many to close down. It has been impossible to list them all, and changes are so rapid in such mines that any list soon becomes inaccurate. Some drilling has been done east and southeast of Montezuma for coal 9 and it there has its usual thickness. At Oaklty School one and a fourth miles southeast of Montezuma coal 9 was found at 80 to 90 feet in depth. Northwest of there it is found in a well on J. W. Hraris' place at a depth of 28 feet and in Mrs. Stone's well at 56 or 66 feet in depth. Near there it is worked at the Luton mines. Farther southeast at the Diamond Coal Company and in many openings in and around Providence coal 9 is always found in its normal thickness of 4′ 8″ to 4′ 10″ and is solid.

Immediately over coal 9 there is always a black shale two to four feet thick. The lower part of this shale contains marine fossils usually as flattened impressions on the shale surface,

The lower part of this shale also contains numerous lenticular concretionary masses of pyrite or siderite, a foot or two in thickness and two or three to 6 or 8 feet in diameter, that project partly down into the coal but are usually imbedded so firmly in the shale that they do not drop. The black shale is quite strong and makes a good roof that requires but little timbering.

The outcrop line of coal 9 across the southwestern part of the county may be seen at a glance from the accompanying geological map. From this outcrop line the dip is to the northeast at the rate of 100 to 200 feet per mile.

The shales just above coal number 9 have been mentioned in describing the sandstone above them, which in the Clay region cuts down in places thru them and there cuts local channels into the underlying number 9 coal. Above this sandstone the section up to coal 11 is chiefly shale. In some places this shale has a thin coal or some black shale at the horizon of coal 10, and here and there a 10 or 15 foot sandstone occurs in the shale between coals 10 and 11.

Coal 10, when present, occurs in southwestern Webster at a varying distance of 30 to 45 feet above coal 9. It is frequently entirely absent, however, and in other cases is represented by only a few inches of black shale. When present it is usually only one or two feet in thickness, though in the shaft of mine 3 of the Providence Coal Company, a record of which is given on page 161, it had the exceptional thickness of 4 and 3/4 feet but showed its irregular pockety character even in the area of the shaft. At no point in Webster county has it been found thick enough to attempt to mine.

Coal 11 is found at an average interval of 80 to 90 feet above coal 9 in southwestern Webster. In the air shaft of mine 6 of the West Kentucky Coal Company at Wheatcroft the interval is 80 and 3/4 feet. In Baker bore No. 1 near the railroad between Baker mine and Wheatcroft it is 83 feet; in well 4 on Sidney Hill farm 150 yards east of Baker shaft it is 86 and 5/6 feet. Near the new Blackwell shaft south of Clay it is 82 feet. In the shaft of the Providence Mining Company's shaft mine 3 the interval is reported by one record as 60 and 3/4 feet and by another as 68 feet. In the Justice No. 1 bore two miles east of Providence it is 88 feet.

Thickness. Coal 11 has a total normal thickness of 61 to 73 inches and in a given mine is subject to considerable variation from this average. In some places it thins a foot or more by being partly cut out on top by the limestone roof, while in other places it thickens a foot or two by downward rolls or sags in the floor. Thin areas are linear in shape and a few feet to some yards across, while thicker areas are roughly circular in shape and from a few yards to some rods in diameter. The thin belts are doubtless due to old erosion channels cut after the deposition of the coal while the thick areas result from the presence of basin shaped depressions in the floor on which the coal formed. In no mine now worked in the county are these irregularities in thickness of any practical consequence, the thin ones are not thin enough or frequent enough to be of material hurt nor are thick ones abundant enough to be of material help.

When present in normal thickness coal 11 has an extremely characteristic section that enables it to be instantly recognized if the full section is visible. There is always present a parting of blue or gray clay 1½ to 2 inches thick and known as the blue band, that separates the lower third of the coal from the remainder. Furthermore, in the upper two-thirds of the coal there is nearly always a pyrite or sulphur band, from a mere knife edge to ¼ to ½ inch in thickness and about 9 to 16 inches below the top. With the blue band above mentioned, this sulphur band separates the coal into a top, a middle and a bottom coal. The detailed character of these divisions may be seen by reference to the coal sections given with the analyses.

In poor natural exposures it may not always be possible to use the coal section to identify coal 11 but in such case resort may be had to another guide that has been found to be infallible so far in the western half of this western Kentucky coal field, namely, the fusulina-bearing character of the overlying Providence limestone to which further reference will be made on a subsequent page in discussing the limestone of the Carbondale formation.

Absence of Coal 11. This coal is not so reliable in its presence as coal 9 but is found to be absent in a considerable part of the county either because of original non-deposition or because of subsequent erosion. Where absent, it is popularly referred to

as being "cut out." In most of such places the writer believes it was never deposited and hence cannot be properly referred to as having been "cut out," while in others he believes that it was once present but was later removed by erosion or was "cut out" in the proper sense of that term.

In the case of original non-deposition it is conceived that low hummocks existed in the swamp in which the coal vegetation was accumulating and that these hummocks were never covered with swamp deposits of carbonaceous matter just as hummocks or islands entirely free of swamp deposits exist today in the great swamps of Florida and other regions. The period of coal formation ended by a subsidence that permitted the formation of the marine limestone that is found above coal 11. The islands that existed in the swamp when the coal forming period ended were submerged in some cases and received the deposit of this limestone just as the coal swamp area did, while in other cases they seem to have remained still above water level as low islands that never received a covering of limestone.

The conditions found about Clay where there is an extensive area in which coal 11 is absent favor the theory of original non-deposition. As shown by outcrops and by borings there is an area that begins at the old Toga mine a mile southeast of Wheatcroft and extends southeastward for some five miles nearly to the Lever mine, in which coal 11 is absent. For part of this distance west of Clay no surface trace is found of the Providence limestone that usually lies immediately over coal 11 and the same thing may be said of some of the bore hole records about Clay. For the rest of the distance on either side of the area where the limestone seems lacking it is represented first by a thin gray to white clay that nearer the edge of the area without coal changes to a highly impure limestone that on leaching leaves a light, porous, yellow rottenstone. At Wheatcroft this rottenstone phase extends for a short distance from the area where the coal is lacking out over the adjacent area where the coal is present in normal development. This rottenstone phase is typically developed and well exposed at some old workings near the brick yard in the southeastern edge of Wheatcroft and there has coal 11 fully developed just beneath it. South of Crab Orchard creek on the first hill crossed by the road from Clay to Provi-

dence, there are small boulders of limestone and soft clay and on the eastern edge of the same hill the rottenstone phase is well developed in a shallow railroad cut a few rods south of the new Blackwell—now Clifty Consolidated—shaft. Rottenstone is again found a mile to a mile and a half southeast of there in the hills on the east side of the railroad. An excellent exposure is also seen in the road a few rods north of the Oakley School.

This rottenstone is usually well filled with casts of fossils that include a number of shore or shallow water forms. The local presence of the rottenstone itself indicates a nearby land area from which fine siliceous and argillaceous material might be derived while the limestone was forming. That this land area had also existed just previously while coal 11 was forming is indicated by the presence in the eastern workings of mine 4 at Wheatcroft of several thin clay partings in the coal in addition to the main blue band as shown in the section of the seam given on page 239, where sample for analysis 3558 was secured. These partings thin out and disappear toward the west and indicate a local source of argillaceous material to the east of Wheatcroft when coal 11 was accumulating. It is believed that these thin clay bands will be found to thicken and probably become more numerous as the workings are extended farther eastward and that the coal will finally give out in that direction by splitting and wedging out between thickening clay bands and not by being cut off by an erosion plane coming down on it from above, as would be the case if it had once existed over the area where it is now absent and have subsequently been removed by erosion. These thin clay stringers are not found in the western workings of mine 4 nor in mine 3 immediately adjacent to the west so far as the writer's observation showed.

Along its outcrop from the Lever mine at locality 52, southeast some three miles to Providence and on into Hopkins county coal 11 is present in normal thickness. The outcrop line of its horizon lies slightly to the southwest of and close beneath the line that marks the upper boundary of the Carbondale formation. Like all other formations in southwestern Webster it dips gently to the northeast into the Webster syncline, and rises

again to the surface in the Sebree region where its horizon may be readily identified by the presence of the overlying fusulina limestone, but where the coal itself is in most places absent.

The roof of number 11 coal may be formed by the Providence limestone resting directly on the coal, or between the coal and the limestone there may be from a few inches to 4 feet of black shale that is usually filled with the spines, dermal plates and teeth of fish, and may have between it and the limestone a few inches of a soft gray clay or gob. In some places the space between the coal and limestone is occupied by gob alone. This gob averages 4 to 6 inches in thickness but may vary up to 18 or 20 inches. After the coal is removed the gob soon softens and comes down. The black shale usually remains up unless it is thin and overlaid by thick gob. Either the limestone or the black shale makes a good roof, though in a few cases the writer has seen the limestone so thin that it occurs as loose boulders which drop out and cause trouble. Such thin areas are rare and involve only a few square rods of roof.

Coal 12. This coal occurs at an interval that varies from 4 or 5 to 22 feet or slightly more above coal 11 and between the two is the Providence limestone presently to be described. Coal 12, when present, varies from a mere trace to seven feet or more in thickness, and the variation in the details of the section is equally marked so far as opportunity has been found for examination. The quality of the coal is generally so poor that but little attention is given it and only in rare cases is there opportunity to examine or measure it. It is usually very dirty and clay or hard rock partings may occur so numerously as to break it into thin benches.

In the Shamrock air shaft it is 5 feet thick with rock scattered irregularly thru it. In the Webster County Coal Company's shaft it is 6 to 7½ feet thick with an 8″ parting a third of the way up from the bottom. In several natural exposures about Providence it varies from 4 to 5 feet as a maximum with one or more clay partings that usually run from 4 to 8 inches thick.

Its outcrop in southwestern Webster is close above the outcrop of coal 11 and very close beneath the line marking the top of the Carbondale formation as it crosses the county from

Wheatcroft to Providence. At no place in that distance is coal 12 known to be of any commercial value, while in part of that distance it is absent entirely. It is present as a thin coal in places in the area about Clay where coal 11 is absent, though over much of this area it is also absent.

Above coal 12 in southwestern Webster county there may be as much as 10 or 20 feet of soft gray shale before the top of the formation is reached at the base of the Anvil Rock sandstone. In some places, however, this sandstone rests directly on number 12 coal and in other places has apparently cut out the coal and rests on the limestone over number 11 coal.

In northeastern Webster county where another considerable area of the Carbondale formation occurs, the basal member, the Sebree sandstone, is prominently developed in the hills both east and west of Sebree. It will be described on page 97. In contrast to this sandstone, which here caps the Sebree hills and is well exposed, the succeeding rocks are shales of such soft texture that they have weathered away to form valleys. These are now filled with alluvium so that the shales are generally concealed. Around the west end of the Sebree anticline in the vicinity of Marksville is the best place to study the lower part of the formation in this region.

A half mile north of Marksville thin coals are exposed at several points along the headwaters of a branch of Knoblick creek. A few hundred feet east of the Wood or Sparks mine a heavy black shale and a black argillaceous limestone are exposed in the branch that are very probably at the horizon of coal 8b. Several hundred yards east of there a heavy black shale that is probably at the same horizon, is found on either side of a small fault and down the branch from the highway bridge two coals show; the first and higher one is almost under the bridge and is probably 8b coal and below it is a 5 inch coal that is probably 8a. Dips vary from 4 to 10 degrees S. 70° to 90° West and several small faults occur to help further obscure relationships.

Four miles southwest of Sebree on the south side of Knoblick creek a 30 or 40 foot sandstone develops in that part of the formation close beneath coal 9 and forms a prominent ridge that

may be followed westward nearly to Ortiz where the interval changes to a series of thin sandstone layers with interbedded shales.

In the northeastern part of the county, coal 9 is brought to the surface by the Sebree anticline and outcrops on the south side of that uplift in a line the eastern part of which is concealed by the alluvial deposits of the Green river and Deer creek flood plains.

On the southern side and western end of this anticline the outcrop of coal 9, as may be seen by the geological map, passes just north of Ortiz and then curves to the northward as it rounds the western end of the Sebree anticline and is there itself cut off by the Rough creek fault. The Wood or Sparks mine is on number 9 coal, and in former years this coal was also worked extensively at the Grayson mine and in a small way at a number of points near Ortiz.

South of Sebree the dip of this coal is from 9 to 20 degrees S. 20° to 30° E. Near Marksville it changes to the south, southwest and west and decreases to 6 or 8 degrees on the nose of the anticline.

The quality of this and the other coals of the formation will be discussed in the economic section on page 175.

From number 9 coal up to the horizon of number 11 coal in the Sebree region the interval is about 113 feet, as shown in the shaft of the Sebree mine. Elsewhere in that region the interval is hard to determine because of steep dips and poor exposures. The rocks between coals 9 and 11 are mixed shales and sandstones. About Marksville these are in alternating beds of no great thickness. At Sebree, there is a 58 foot sandstone close above coal number 9.

At no place in northeastern Webster was coal number 10 found in surface exposure. It is absent in the Sebree shaft and in the bore hole records. In a few places about midway or slightly above midway of the interval between coals 9 and 11 there is a soft gray clay that may represent the horizon of coal 10.

Coal number 11 is reported in the Sebree Coal and Mining Company's shaft to be 4′ 9″ thick but the writer found only 2′ 6″ on the west side of the shaft where alone it was accessible.

In the northeastern edge of Sebree several shallow shafts were once sunk to its horizon and some coal was found but it proved unreliable and they were soon abandoned.

A few rods north of the Prow mine at locality 19, east of Ortiz, there is a thin black shale that is overlaid by a thin clayey rottenstone layer with obscure traces of marine fossils that is considered to be at the horizon of coal 11 and 400 yards east of there in a spring a heavy black shale is found at the same horizon. In each case coal 9 crops a short distance to the north. At no other point on the south side of the Sebree anticline has any trace of coal 11 been found although the overlying fusulina limestone is exposed at a number of points on both sides of the Sebree anticline as well as in the region north of the Rough creek fault between Sebree and Green river, as will be described when discussing that limestone.

It seems that over most of the Sebree area coal 11 was not generally deposited, although here and there on the low-lying land surface of that time there were occasionally small swamps in which some restricted areas of this coal were formed. It is probable that there was also some erosion of the small areas in which coal had been formed from the abrupt way in which it is said to run out and from the fragments of carbonized wood occasionally found in the overlying limestone as, for instance, at an excellent exposure at locality 20 one and three-fourths miles west of Sebree.

In the Duncan well at Tilden coal 11 is believed to be absent.

In northeastern Webster where coal 11 is so generally absent coal 12 is found in places and although quite variable in thickness is of better quality than in the southwestern part of the county. Two miles west of Sebree there is a small area of it on the farm of Frank Sanders. It is a good coal there and 40 inches in thickness. At Marksville it has been mined for a number of years by the Marks Coal Company. It is solid there and varies from 3½ to 4½ feet with an average near the larger of these figures. A mile and a half east of the Marks mine D. L. Prow has opened the same coal. The dip there is 16° S. 30° E. Being a country bank it is operated only during the winter. It stands full of water all summer and when visited could not be

entered. Its thickness was reported as four feet. The outcrop for some distance east and west from both the Marks and the Prow openings is occasionally accessible to observation in gullies and shows a coal very variable in thickness. The overlying Anvil Rock sandstone in places rests directly on the coal and in places has cut it out either wholly or partly. This top coal at Marksville is here considered to be coal 12 because of its relation to coal 9—known there as the Sparks or Wood coal, from its relationship to the horizon of coal 11 found a few rods north of the Prow opening and some 45 feet lower stratigraphically, and from its position just beneath what is there considered to be the Anvil Rock sandstone. Elsewhere in the Sebree region coal 12 is generally absent. There is no trace of it in the shaft at Sebree or in the well drilled in 1904. The roof of coal 12 is usually a gray shale, though in part of the Marks mine it is black shale, while in places there and elsewhere the roof is the Anvil Rock sandstone.

In a few places there are a few feet of limestone over coal 12, as for instance in the log of the short churn drill hole at the face of the slope in mine 4 at Wheatcroft, given in graphic vertical section in plate No. 20. This limestone is, however, very variable and may disappear in a short distance. It is absent in the drill hole 2,900 feet from the above mentioned hole as may be seen in the same plate.

Divisions of Carbondale Formation. In the general assemblage of shales, sandstones and limestone that compose this formation, it does not seem necessary to differentiate but two members by name. These are the Sebree sandstone at the base and the Providence limestone near the top.

Sebree Sandstone. The basal member of the Carbondale formation is a coarse sandstone that is almost always massive and prominent and may be discriminated from the main body of the formation as a separate member to which the name Sebree sandstone is here applied from its prominent development between Sebree and Steamport Ferry where it caps the hills and in places forms prominent cliffs.

It is the first coarse grained as well as the first prominent and persistent sandstone found above the conglomerate of the Caseyville formation. In a few places it is only 10 or 12 feet

thick and is then apt to show strong and irregular current bedding and be filled with impressions of drifted trunks of lepidodendron and other Coal Measure trees. In other places it is 40 or 50 feet, or possibly somewhat more, in thickness, and shows prominent cross bedding. Much of the cement is ferruginous and in places sand-ironstone plates or seams are prominent in it. It usually stands out as a prominent cliff-forming sandstone and in southwestern Webster forms the bold southwestward-facing scarp line described in the topographic section of this report as extending across the county from Sullivan to Yarbro and separating the Tradewater lowland from the Providence upland. In the Sebree region it is the resisant element to which the existence of the Sebree upland is due.

Providence Limestone. There is but one well marked limestone horizon in the Carbondale formation. This one occurs immediately or within a very few feet above coal 11 and is usually 5 to 8 feet thick. Excellent exposures are found in and about Providence and it is here called the Providence limestone. In a few places it thins to a mass of separate pieces a foot or less in thickness, or as in the Clay region, described somewhat fully on page 85, it may be entirely absent. Occasionally it thickens to 10 or 12 feet and in some cases is split into two members by a few inches or feet of gray calcareous shale. It is a blue argillaceous limestone usually quite impure and variable in composition and irregular in bedding.

About the borders of the Clay area in which the underlying coal 11 is absent this limestone becomes highly impure and weathers, as we have seen, to a porous yellow rottenstone. It contains marine fossils, one of which, Fusulina cylindrica, has not been found by the writer anywhere in the western half of this coal field at any horizon except this and hence has served as an excellent key fossil. This fossil is not very numerous and yet may always be found by careful search and has proved very valuable, especially in the badly disturbed region along the Rough creek fault, in discriminating the Providence limestone from other limestones of Pennsylvanian or Mississippian age. A list of the fossils found in the Providence limestone has been given on page 58. Most of these were obtained from the rottenstone phase of the limestone.

Distribution. There are three areas of the Carbondale formation in the county. The main area is in the southwestern part and crosses the county from northwest to southeast in the Wheateroft-Providence region. This area almost coincides with the Providence upland. Its southwestern margin is the Sullivan-Yarbro scarp made by the Sebree sandstone. In the Wheateroft-Clay region dips to the northeast average slightly more than 2° in a direction N. 35° E. and are somewhat greater than in the Providence region where they average not over 1½° N. 23-25° E. and hence the outcrop belt is narrowed to two miles in width near Wheateroft and reaches four miles near Providence. This dip carries the formation down into the Webster syncline to the northeast at the rate of 135 to 180 or 200 feet per mile, so that coals 9, 11 and 14 soon become too deep to be reached under present mining conditions.

The second area of Carbondale rocks is found in the northeastern part of the county where the rocks that disappeared in the Providence region by dipping northeastward into the Webster syncline, rise to daylight again in the Sebree anticline. This Carbondale area almost coincides with the Sebree upland. On the south side of this upland there are a few separate outliers of Carbondale rocks that protrude like isolated islands from the Deer creek lowland. The largest of these are found just east or just west of the Louisville and Nashville railroad. This area is an elongated dome whose northern side is limited by the Rough creek fault, as may be seen from plate No. 21. The dips on the sides and end of the Sebree anticline usually run from 5 to 20 degrees.

The third is a very small area in the Graves creek and Green river valley in the extreme northeastern corner of the county. It is mostly concealed by the alluvial filling but on low slopes or along ravines shows at a number of places the Providence limestone. Some of the patches of outcrop are so small that it has been necessary to represent them somewhat conventionally on the geological map. The Providence limestone in this area dips to the northwest so gently that it may be described as lying almost flat.

Economic Materials. The chief economic material of the Carbondale Formation is its coal. Coal numbers 8a and 8b are

nowhere of economic value and may be dismissed from further attention. Coal number 9 is the most regular and valuable coal in the formation. Coal number 10 is of no value in Webster county although it is mined in a small way at DeKoven in Union county. Coal number 11 is next to number 9 in importance but is not so reliable in occurrence, especially in the northeastern side of the county. Coal number 12 is of value only in restricted areas such as are found at Marksville and Ortiz. The general stratigraphic relations of these coals have been given in preceding pages and only a discussion of their special characteristics need be given here. Analyses and detailed sections of the seams will be found in a later chapter.

Coal No. 9. This name or number was given by Owen. It is the same as the number 5 or Springfield coal of Illinois. This is generally regarded as the standard coal of the district. It is without parting, is of good average thickness—say 4′8″ to 4′ 10″ in southwestern Webster and slightly less in the Marksville-Sebree region—is very uniform in its thickness, and except near Clay, is everywhere present where its horizon is found. It has a good roof of black shale, breaks out in satisfactory sizes, is hard enough to ship well and is said to stock well. In quality it is surpassed only by the Bell and the Baker or No. 14 coal. The latter is now mined by the West Kentucky Coal Co. of Sturgis, at their Baker, or No. 5, and their No. 7 mines near Clay. The Bell coal is much lower in the coal-measure series, does not outcrop anywhere in the county and is not now mined anywhere in the region so far as known.

The roof of coal 9 consists of several feet of tough black shale that stands well with little or no propping. Its under surface may be smooth and sheety or it may in some places have rounded or lenticular concretions of pyrite or siderite that project part way down into the coal. These concretions range in size up to several feet in diameter and may either come down or remain attached to the roof. In many places this black roof shale contains fossils of marine invertebrates beautifully preserved in macasite or pyrite or as impressions. Occasionally there are fish plates, teeth or spines.

The black shale may rest on the coal or there may be several inches of a hard dark clay between them.

The top 15 or 18 inches of the coal itself is somewhat harder than the rest of the seam and shoots down in larger lumps. It is composed of alternating bright pitchy or resinous and dull splinty layers, and owes its hardness to the presence of the latter. The coal in the middle 2½ feet is softer, breaks out in smaller lumps, produces a larger proportion of slack and has a larger proportion of bright glistening coal. It probably contains a larger percentage of volatile matter than the harder top part. The bottom 6 to 12 inches is again harder like the top and contains most of the sulphur. The sulphur occurs in thin horizontal and vertical branching sheets or binders of pyrite or marcasite and not as rounded or nodular balls. In some places these binders are abundant enough to make considerable hand picking necessary as it is loaded.

The average of the various analyses of this coal given in the chapter on coal analyses, will give a very fair idea of its average quality, though the variation from place to place in the same mine or even the same room is sufficient to make any one of the analyses misleading so that no mine listed in the tables of analyses will uniformly turn out a product as good as the best analysis or as poor as the worst one. In any mine whether on this or any other coal the analytical showing can be kept at its best by constant care in producing clean coal. This, in the case of number 9 coal, means, especially in certain mines, care in picking out the lumps with sulphur binders. Mines where these are abundant can remove them so as to market as clean a coal as mines that are practically free from them. Details as to thickness of seam are to be found in the chapter of coal analyses. No attempt is made in this county to coke it, though it has been coked at DeKoven and used in industries such as pyritic smelting where the sulphur content is not objectionable. The coal is widely used for general steam and domestic purposes. From its good quality, regularity of occurrence and great area number 9 coal is much the most important coal in the county.

Coal 11 is generally considered not quite so good in quality as coal 9 but if the analyses here given of the two coals are compared there will be found to be very little difference between them and no single analysis of either coal shows such distin-

guishing features as would enable a given sample to be assigned to either of these coals rather than to the other. See individual analyses on pages 178 to 220 and averages on page 175.

The average detailed section of this coal has been given on page 90. The top bench, above the sulphur band, is an especially fine, clean, bright coal and contains less sulphur than the rest of the seam. The middle bench is also good and relatively free from sulphur. The bottom bench carries in its lower 6 or 8 inches most of the sulphur of the seam. In mining, the blue band separates readily from the coal and while not quite so hard as the upper part of coal 9, it shoots well and bears transportation well. Like 9 it is too high in sulphur for its coke to be used in iron furnaces but it might be used for almost any other purpose. None of the Webster county production, however, is coked but it all goes to the steam and domestic trade in direct competition with coal 9.

Coal 12 is mined only at Marksville and Ortiz to supply the local demand. It is used chiefly for domestic purposes and makes a very satisfactory fuel. It is medium soft, breaks in rather small lumps, is clean and bright and shows very little sulphur, although in the single analysis given the sulphur is rather high. As compared with the other coals here analyzed it is higher in volatile matter and lower in fixed carbon and moisture, and would be classed as a free burning coal, primarily suited for domestic use and probably for gas making.

The area where coals 9 and 11 are readily available for commercial development in the county is quite large. It includes not only the outcrop area in southwestern Webster, which may be worked now for several miles down the dip from the outcrop, but also all of the county north of the Rough Creek fault, or north of a line that crosses the county from Tilden to Sebree. In the eastern part of the area north of this fault line coal 9 lies 100 to 150 feet beneath drainage level while to the west the depth to it increases slightly until in the Tilden region it is 300 to 400 feet.

In the deepest portion of the Webster syncline in a large area in the middle of the county the depth to coal 9 is now too great to make it a present economic asset, but the day cannot be far distant when it will be practicable to reach it anywhere in

the basin, so that it is there to be looked upon not as out of reach and valueless but rather as a reserve asset to be drawn upon when the need for such draft becomes more acute than it is today. In any section prudence dictates that an area be drilled thoroughly before being purchased or developed.

Aside from the coals of the Carbondale no other material is utilized today to any extent. The Sebree sandstone is occasionally quarried locally for chimneys, foundations and bridge piers and some of the thin hard sandstones close above it are similarly used. The Providence limestone is generally too impure to be burned for lime. It may be used occasionally for rough foundation work. It could be crushed and used for macadam and in fact with the Mississippian limestones locally available along the Rough creek fault is about the only good road building material that the county has.

Lisman Formation.

Definition. This formation extends from the top of the Carbondale up to the base of the Dixon, or in most of the county from the base of a prominent sandstone close above coal 12, known as the Anvil Rock sandstone, up to the base of the Dixon sandstone. In part of the county where the Anvil Rock sandstone is absent, the base is usually formed by the lowest one of a series of thin limestones or marly clays. The town of Lisman is situated well within a broad outcrop of the formation and gives it its name.

Thickness. No direct measurement of the thickness of this entire formation has been made, but sections constructed with the aid of the deep bore holes of the West Kentucky Coal Company indicate that it is 900 to 1000 feet thick. One calculation gives 943 feet, while another gives 963, and it is known from certain well records that parts of the section vary somewhat on either side of the figures used in the above calculations. This makes it the thickest formation in the county.

Character. The formation is composed chiefly of a great body of soft shales, with usually a prominent sandstone at its base and a number of thin limestones in its lower half. It has a number of coals scattered throughout it, but all are thin and

worthless except one near its base that is locally thick and valuable. This one is known as the Baker coal or coal number 14, because another coal occurs in places between it and coal 12.

Shales. Some of the shales are sandy and here and there may grade into soft sandstones that are usually only a few feet thick, while others of the shales are argillaceous and occasionally marly. Where sandy they are blue or gray and often quite dark when fresh but become rusty yellow when weathered. Where marly they incline to a leaden color or may be greenish or at one or two horizons become mottled with red or pass into typical marly red shale.

This red shale phase has not been observed anywhere in surface outcrop but is known both from the cores of drill holes and from the materials from the shaft of mine 7 of the West Kentucky Coal Company. The more marly shales are associated with thin limestones and are very variable both in color and in the details of the section that the assemblage presents, as may be readily seen from the sections given of the two shafts of mine 7.

The sandy and pure clay shales occur, as the drill records show, in beds of considerable thickness, ranging from 100 to nearly 200 feet each. The marly and red beds are rarely over 8 or 10 feet each in thickness.

The horizon of the red beds is about 200 to 225 feet above the base of the formation. So far they have not been found at any other horizon in this county in the Pennsylvanian and hence may serve as a guide in helping determine horizons in deep drillings in the southwestern half, at least, of the county.

Sandstones. The base of the Lisman formation is, over most of the county, a sandstone that varies in thickness from nothing up to 55 feet. It is the Anvil Rock sandstone of Owen. It is normally a coarse, soft, loosely cemented, ferruginous, crossbedded sandstone, usually massive in bedding and occasionally, especially in the northeastern corner of the county, conglomeratic in character.

The Sebree sandstone was described as the first coarse sandstone found above the Caseyville conglomerate. This Anvil Rock sandstone is coarser than the Sebree and indicates a marked incursion of a sea with strong currents across a low-lying land where coals, clays and limestones had been accumulating. The

thickness and character of the Anvil Rock sandstone vary considerably. Normally it is 20 to 40 feet thick, but in the Clay region where coal 11 is absent, this sandstone is also either absent, as seen in numerous drill holes, or is broken into separate members by shale partings as may be seen in the logs of the two churn drill holes given on plate No. 20. At Baker it is absent and it would seem that over a considerable area where the Baker coal is present this sandstone is absent.

In one core record in the Clay region there is a sandstone, in part conglomeratic, with its base at about the Anvil Rock horizon, that extends upward for 181 feet, while other nearby records show the same vertical interval filled with shales, limestones and thin coals.

From this it seems that a sandbar must have formed at that time in the Clay region near the shore and have shut off an area of quiet lagoon and coal swamp back of it where beds of clay, of coal, and of thin limestone accumulated while slow subsidence allowed the bar or barrier beach to increase in thickness as shown by the drill record. The width, direction and length of this old barrier beach could only be determined by far more extensive drilling than has as yet been or probably soon will be, done in the region.

Areas of Anvil Rock sandstone may be seen in and west of Wheatcroft, on the hill top west of the new Blackwell, or Clifty Consolidated, shaft, and on the hills in and north of Providence where it assumes a finer and more shaly phase than it elsewhere exhibits. Its position may be readily determined by the fact that it is the first sandstone over coals 11 and 12.

It is also well exposed in Marksville where it is close above the Marks or number 12 coal. East of Marksville it forms the crest of the ridge on which Ortiz is situated and may be traced east at intervals for some eight miles until it is finally concealed by the Green river flood plain. The most eastern point where it is exposed on the south side of the Sebree anticline is at the school house 3½ miles southeast of Sebree on the road to Onton. It is there coarse and soft but has no pebbles in it. North and northeast of Sebree it is poorly exposed for short distances in road cuttings and along a few minor stream ways in the valley of Graves creek and there usually contains scattering pebbles of

vein quartz less than an inch in diameter and rolled and flattened pebbles of Pennsylvanian shale up to 2, 3 or 4 inches in diameter. There is a well marked unconformity at its base.

Above the Anvil Rock sandstone there is no strong or persistent sandstone in the Lisman formation, although several thin sandstones occur in the bore hole records and one occasionally finds in surface outcrop a local development of a ten or twenty foot sandstone.

Limestones. There are two prominent groups or horizons of thin limestone in the lower part of this formation and other less conspicuous limestones in the middle and upper parts. The first or lowest of these groups extends from the base of the formation up 25 to 40 feet. Only a small part of this interval, however, is occupied by limestone beds, for they occur as a rule in layers from 2 to 5 feet thick, though in one record, bore 2 of the West Kentucky Coal Company, there is an 18 foot bed of what is doubtless limestone close beneath the Baker coal, though designated flint rock in the log.

The second group consists usually of three thin limestones, the lowest some 200 or 225 feet above the base of the formation, and the topmost one some 20 to 35 feet higher. In the records accessible these limestones range from 1 to 7 feet thick. The topmost one is believed to be the Madisonville limestone. The red shale described in a preceding section occurs in the interval occupied by these limestones, and along with it there are other shales usually dark, argillaceous and marly.

In southwestern Webster these limestones are only known in drill and shaft records. They are either removed by solution from their surface outcrops or they are covered by loess or alluvium so that they do not appear on the surface.

After the Lisman formation rises to the surface on the northeast side of the Webster syncline these limestones outcrop at a number of places. A mile west of Marksville there is a small outcrop in the road to Dixon. Again, east of the Louisville and Nashville railroad an outcrop is seen a half mile north of Breton station that rises to the north and may be followed first north and then eastward to Onton in various small exposures along the upper slopes of the northern margin of the Onton upland. The best exposures are seen at G. C. Spring-

field's at locality 21, although a number of ravines from there eastward to Onton also afford good exposures. Although there are no continuous sections of any great length in that distance, yet it seems certain that just as in southwestern Webster there are several beds here also.

Where the road from Sebree to Slaughtersville crosses Deer creek there is a good exposure of one of the limestones belonging in the lower group, or in the basal part, of the Lisman formation.

In the middle of the formation, 270 feet above the top of the Madisonville limestone in bore 21 of the West Kentucky Coal Co. there is an 8½ foot limestone. This is not known with certainty except in this bore, though in the northeastern side of the county where this formation outcrops there are occasional isolated boulders of limestone that may belong at this horizon, although there is nothing distinctive about them and they are too impure and restricted in outcrop to be of economic value.

In the upper half of the Lisman formation there are also found a few surface exposures of thin limestones, but in the absence of drill records it is impossible to say whether they occupy a constant horizon or occur merely as locally developed lenses at several horizons. So far as known they occur within about 100 feet below the top of the formation. The best exposure of this high limestone is found some 2½ miles southeast of Stanhope, a short distance across the line in Hopkins county. Limestone is again found in the hills five miles northeast of Clay at localities 22 and 23. In both these and the Hopkins county exposures the limestone is associated with a conspicuous sheety black shale or a black shale and a thin coal.

Coals. With the exception of one locally developed thick coal near its base the Lisman formation is normally barren of workable coal. Along with its sandy and reddish shales, its marls and thin limestones there are a few coal seams, but while apparently quite persistent over the small area where they have been revealed by the drill they are only a few inches in thickness as may be seen in logs 19, 20 and 21 of the West Kentucky Coal Company.

Baker Coal. The exception among these coals occurs some 23 to 43 feet above the base of the formation where, in the region

north of Clay, there is found a coal of good thickness and excellent quality, properly to be called coal 14 if named in the numerical order of its occurrence in the region where it is found in Hopkins county, but better known as the Baker coal. It is the same as the Nebo coal and also occurs about Nortonville, Corydon and Smith's Mills.

It was discovered by accident by F. M. Baker when drilling for coal number 9 between Clay and Wheatcroft. At first no attention was paid to it but the shaft at the Baker mine was

NO. 18. TIPPLE AT BAKER MINE.

The Baker of No. 14 coal was first worked at this mine near Clay, now owned by the West Kentucky Coal Co.

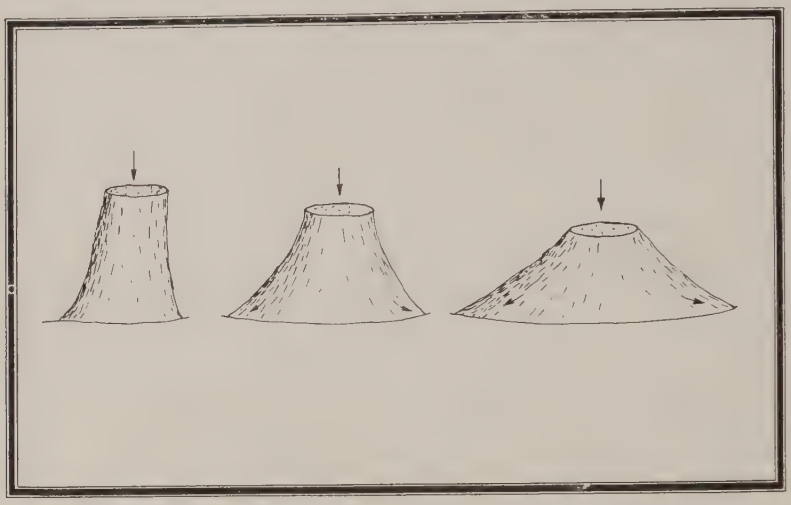
sunk on down to coal number 9 and for a time this coal was mined. Later a test of the higher coal was made and it was found of such promising quality that the owners developed it and abandoned coal number 9 in which some gas had been found and some troubles, reported by several parties as "faults," but probably erosion channels instead, had been met with and had caused considerable difficulty in the development of the mine. The Baker mine tipple is shown in plate No. 18. Further exploration with the drill revealed a considerable area to the north of

the Baker shaft and this new territory has recently been developed by mine 7 of the West Kentucky Coal Company, the largest mining shaft doubtless in the state.

The Baker coal soon lenses out to nothing around the outcrop edge of the Baker area but where fully developed down the dip there is from 6 to 7 feet thick and is solid. Beneath it there are a few inches of thin, flaky carbonaceous rash, while over it there is an inch or two of similar carbonaceous rash and then 12 to 18 inches of gray clay that is quite unctuous and badly slickensided. Above this clay there are one to three inches of coal and carbonaceous shale or in places one-half inch of very bright, pure soft coal. Over this there are either a few inches of gray clay, much like that below, or a soft shale a foot or two thick that grades upward into a mixture of sandstone and shale, interlaminated in layers a tenth of an inch or less in thickness.

Just above the thin coal stringer or coal and shale there are many flattened tree trunks and numerous stumps of trees standing in their original position with their cortical portion represented by one-half to three-fourths of an inch of bright coal and their interiors filled with clay or shale. These stumps spread very broadly at their base and form, as it were, low cones that frequently drop from the roof without warning and are known as "bells" because of their peculiar shape. It would seem that their bell shape may be due to a vertical foreshortening that they suffered during the setting and consolidation of the clay about them when their interior pith had disappeared and their thin harder cortical substance was partly decayed and probably macerated or softened and might be readily deformed by vertical foreshortening and periphereal spreading, as illustrated in plate No. 19.

The soft, incoherent character of the clay above this Baker coal makes it necessary to leave up the top 12 to 14 inches of the coal itself to form a roof while mining. Later most of this is recovered. Even then much care is necessary to keep shots from being placed too high and loosening this top coal so that falls may result. Rooms soon fall in after being worked out and haulways need to be well protected. The coal is of such superior quality that even with the disadvantage of a poor roof it is possible to work it where 5 or 5½ feet of coal may be removed.



NO. 19. TREE STUMPS CHANGING INTO "BELLS."

When buried in the muddy sediment of a coal swamp a macerated hollow stump may settle and spread into a "bell" as the sediments consolidate.

This Baker coal was at first thought to be coal 11 with an unusual development, but drill records show it to lie above coal 12 at an interval of about 20 to 40 feet. Its relation to the Anvil Rock sandstone and to coals 11 and 12 is well shown in the sections on plate No. 20. The Anvil Rock sandstone in these two sections may include both benches between coals 12 and 14.

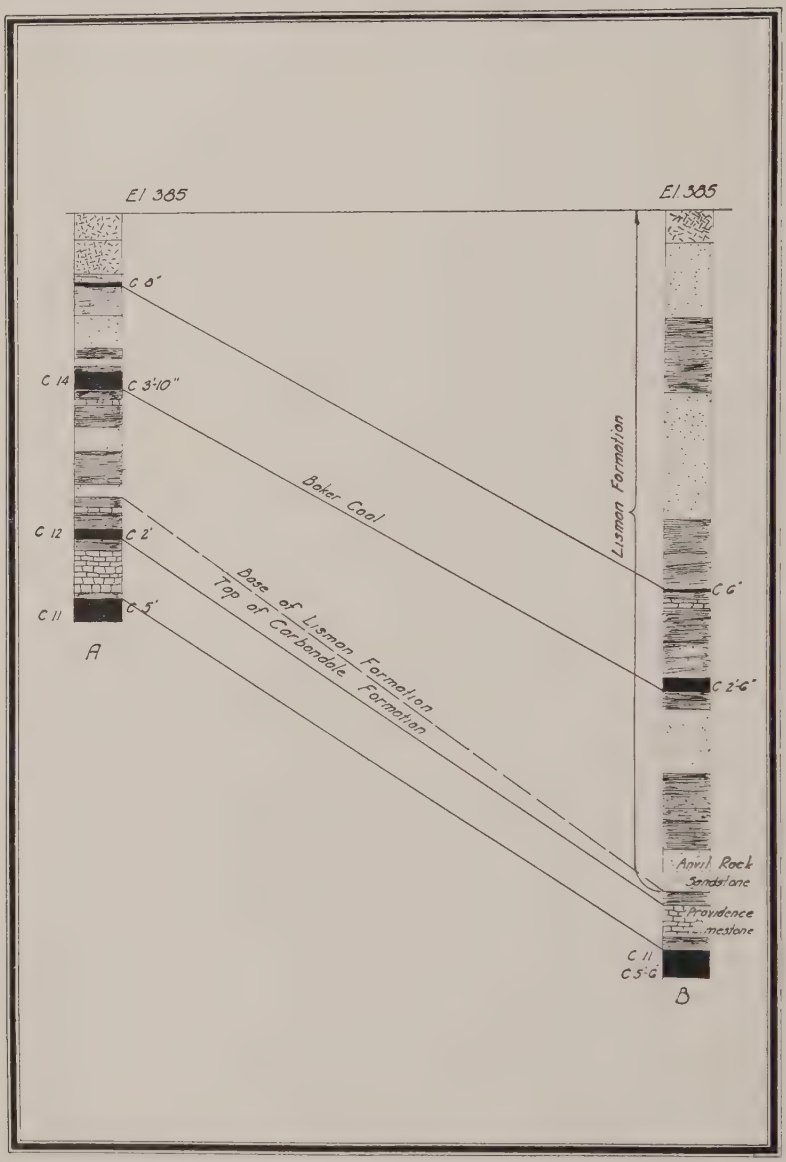
The full extent of its occurrence is not known. From the drilling by the West Kentucky Coal Co. in the region north of the Baker mine there has been shown to be a considerable area of thick coal in that immediate vicinity. This has been developed by this company in their mine No. 7, the largest mine in this region. From the rapidity with which it thins from 6 or 7 feet down to 2½ feet in the 300 or 400 feet between the now abandoned west workings of the Baker mine and the Baker bore No. 1, it would be hazardous to predict the continuity of thick coal for any distance in advance of the drill. It is said to have been found well developed in Clay, but is absent or very thin in the Korf shaft just east of Clay and in the D. B. Baker bore

at locality 18 it is not reported at all, although its horizon was certainly passed through if the hole there is 400 or 500 feet deep, as reported.

The coal mined at Corydon and Smith Mills in Henderson county is believed by the writer to belong to the same horizon as the Baker coal and there may exist a more or less continuous area of good thick coal from Baker northward across the broad synclinal basin in the middle of the county and across the Rough creek fault to join the Henderson county area just mentioned. It is highly probable that the Baker, or number 14 coal, is at the same horizon as a thick coal found at Nebo and elsewhere east of Webster county and generally called coal 14. It is here called coal 14, though there is usually no coal between it and coal 12 in Webster county, as there is often in Hopkins county.

If the designation in western Kentucky of certain coals by numbers such as 9, 10, 11 and 12 had not been so firmly fixed that it would seem hopeless to attempt to change it, the writer would much prefer to designate by a name instead of a number all of the coals of the region that are important enough to warrant naming. The number implies an ascertained sequence while the safety of a name lies in the fact that it does not imply a sequence which in some cases cannot be definitely ascertained and in all cases is subject to change either by the addition, omission or splitting of one or more members of the series.

This hazard in applying numbers to coals is well illustrated by this Baker coal in its relationship at Wheatcroft to coal 11, the identity of which cannot there be in question. As shown in plate 20 if the coals in bore A were numbered from coal 11 at the bottom upward, the Baker coal would be number 13, but if numbered from bore B it would be number 12 since in the 2900 feet between the two holes the intermediate coal in bore A has disappeared. When such confusion in correlation might easily result from the presence or absence of a coal within approximately half of a mile, it is evident that something more than mere numerical sequence is necessary in correlating coals possibly a score or more of miles apart. In a region like Webster and the adjoining counties of western Kentucky where surface exposures are usually very poor and reliable drill records are often entirely lacking over large areas, when widely separated



NO. 20. DETAILED SECTIONS ABOVE COAL NO. 11, WHEATCROFT.

coals are thin and little known and there is litttle or nothing distinctive about them or their stratigraphic setting, it is extremely hazardous to attempt numbering them. This applies especially to the thin coals in the upper part of the Lisman and in the Dixon formations. The matter is not of great practical importance, however, since the coals just referred to are not of commercial and only in rare places even of local importance.

To further illustrate the confusion of numbering, if in West Kentucky Coal Co.'s bore 19 one rekoned upward from Coal No. 9, the Baker coal would be No. 10, but taking the Baker seam as 14 (as numbered here) the coal 391½ feet above the Madisonville limestone would be number 18, while in the nearby bores 20 and 21, it would be number 16, while in the Madisonville region it is known as 14a. In bore 21 four other coals occur above this No. 16, or 18, that might be numbered either 17 to 20 or 19 to 23. It will also be remembered that in the vicinity of the Grangertown bore hole in the near edge of Union county there are 19 or more coals known below what we know as No. 9. All of this is merely illustrative of the well known fact that coal seams are merely lenses, many of which are of small extent and soon thin out and disappear, or of the further fact that a single seam may split into two or more distinct seams or these two or more seams traced in reverse direction may unite into one.

The West Kentucky coal field shows many excellent examples of these rapid and capricious changes in its thinner coal seams, but it is also equally remarkable for the persistency and uniformly of it best developed commercial coal which is known in this state as No. 9 but is called No. 5 in Illinois and Indiana where it underlies a wide area as a valuable coal. Ashley[14] has pointed out that this coal 9 underlies some 25,000 square miles and is probably the most persistent coal in the eastern half of the United States, far outstripping in this respect the Pittsburg coal, which is also noted for its persistence but which covers only 6,000 square miles or less.

The records of West Kentucky bores 20 and 21 show that for 631 feet above the Baker coal, where their logs end, there is

[14] Ashley, G. H., Indiana Dept. Geol. and Nat. Res., 33rd Ann. Rept., p. 93, 1909.

no coal of over 1½ feet in thickness. From the upper end of these logs there is a blank interval of about 120 feet before the surface record on the hillside north of well 20 begins. Part at least of this interval is visible about Hearin and no coal is known in it. In surface exposures north of bore 20 there is developed a thin bony coal with heavy sheety black or blue shale and a dark fetid phosphatic limestone. In places the carbonaceous matter may be all bone and shale and may be in one bed or may in a short distance split into two or three layers. In the road north of L. G. Monroe's at locality 22 the following section is exposed:

Blue black shale at top	2″
Argillaceous marly shale	4′ 0″
Massive blue black shale	1′ 3″
Gray clay with fetid phosphatic nodules	5′ 0″
Bony coal	0′ 4″
Under clay	2′ 0″

At various points for a mile or more east of there attempts have been made to open at this horizon for coal but at no place is the coal of any value. This may be the Geiger's Lake coal of Union county.

A mile northeast of Lisman at locality 24 a coal in a sandy shale interval reported to be 28 inches thick was once opened but soon abandoned. It will be called the Lisman coal. It appears to be 50 to 100 feet farther below the top of the Lisman formation than the bony Geiger's Lake coal mentioned above. At a number of points in and to the northwest and southeast of Stanhope a coal that runs about 24 inches in thickness has been opened. It is in a shale interval, seems of fairly good quality but it is too thin to mine. It may correlate with the Lisman coal as it must be very near if not at the same horizon. Only natural roadside exposures of it could be seen.

On the northeast side of the Webster syncline where the Lisman formation again comes to the surface there are a number of country openings on thin coals, most of which have been abandoned but a few of which are occasionally worked for country use. At an interval of 100 feet or somewhat less beneath the top of this formation there is a persistent coal horizon that may be traced from the vicinity of the Harpshead road eastward to Onton. It shows 15 inches of good coal at locality 24 near W. S.

Shelton's. A mile southeast at Green Chandler's, locality 25, it is 18 inches; farther southeast at locality 26, it was once mined in a small way. No other exposures are known to the east until Jno. Brooks' is reached at locality 27, a mile north of Mt. Pleasant church where it was once opened and found to be 18 inches. It has been opened a mile northwest of Belcourt on the land of W. M. Henry at locality 28. The opening was fallen in, but it was reported to be a solid coal that averaged 28 to 32 inches in thickness, but varied up to 42 inches in places. The roof is there a fissile black shale with several thin streaks of coal, above which there is soft yellow sandy shale that passes upward into a shaly laminated sandstone. It is again known at Onton where it was once opened by D. H. Coffman and found to be 24 inches thick. It is of good quality from Brooks' east to Onton, burns very freely and leaves a small amount of soft ash only, but is too thin to be of any great importance in the near future.

This coal has been best known and most worked in the Belcourt region and will be called the Belcourt coal. It is very probably the same as the Stanhope and Lisman coal.

From a fourth of a mile to a mile, according to the dip and topography, to the northeast of the crop line of the Belcourt coal as just traced from the Harpshead road east to Onton, there are one or two thin coals associated with heavy black shale or thin limestones that have been prospected in a number of places, as especially on the brow of the Onton upland as it overlooks Deer Creek valley. The coal is of no value and time and money are only wasted in prospecting for it. Its horizon is not far above the Madisonville limestone.

The horizon of the Baker coal is concealed beneath alluvium in this part of the county.

Divisions of the Lisman Formation. The basal sandstone when present may be discriminated as the Anvil Rock member of the formation. Its character and mode of occurrence have been described on pages 104 to 106. Another member that may be discriminated is the Madisonville limestone, the occurrence of which has been noted on page 106. It is like all other Pennsylvanian limestone of the region, an impure blue to dark leaden gray earthy limestone that is homogeneous in some places but

much brecciated in others. It is sparingly fossiliferous as most of the others are except when they are brecciated, when fossils are usually entirely lacking.

Areal Development. Like all preceding formations the Lisman formation outcrops in two principal areas, the one on the southwestern side of the county the other on the north and northeast.

Consisting as it does so largely of soft shales that offer but little resistance to weathering and erosion the outcrop area is very largely lowland. The only resistant member is the Anvil Rock sandstone at its base. Its outcrop forms the ridge from Wheatcroft to Providence that slopes with the dip of the rocks gently to the northeast until it merges with the broad Lisman lowland in which most of the shales of the formation outcrop. The upper part of the formation is somewhat sandier and is protected by the basal sandstone of the overlying Dixon formation so that it forms the steep slopes of the southwestern side of the Dixon upland. The upper edge of the formation is so near the axial line of the broad synclinal trough that dips to the northeast have greatly decreased and the rocks lie so nearly flat that their outcrop extends in long finger-like areas up the valleys of the larger streams well into the heart of the Dixon upland. This may be well seen from the geological map where this formation extends up Caney Fork almost to its head, up Farmer's creek to Dixon and up its east branch to Vanderburg.

In the northern and northeastern parts of the county it outcrops in a large area that occupies in general the Deer creek lowland and exhibits the same topographic relationships that it shows in the Lisman lowland.

North of the Rough creek fault from Union county eastward nearly to Green river there is a belt of Lisman rocks several miles wide across the northern edge of the county, that in their western half are adjacent to the Deer creek area but are structurally distinct in as much as the northern border belt lies nearly flat while the Deer creek belt dips from the Rough creek fault sharply southwest.

In both the Lisman and the Deer creek lowland areas the surface outcrops are very generally concealed by the Pleistocene and recent stream filling which, as will be seen later, reaches depths of over 100 feet.

Economic Materials. Coal is the chief economic material in the Lisman formation, and it is confined practically, as has been seen, to the Baker coal near the base of the formation. The stratigraphic position and areal development of this coal, so far as known, have already been given. In character it is a bright, medium soft coal, free from partings and impurities and analyzes low in sulphur, ash and volatile combustible matter and high in fixed carbon. It is thus seen to be of very excellent quality and compares very favorably with any other coal now mined in the county.

Among the other coals the Belcourt coal makes the nearest approach to being of importance and the day will come when coals no thicker than it will be mined where they are of as good quality as it is reported in some places to be.

The formation contains a great weath of shales from calcareous to argillaceous and sandy and could supply unlimited quantities of any of these kinds of material for brick and tile making. The Anvil Rock sandstone is too soft to be of value as a building stone. It could be easily crushed for use as building sand and north of Sebree is adjacent to the railroad for convenient shipment.

Dixon Formation.

Definition. The formation includes all Pennsylvanian rocks in the county of younger age than the Lisman formation, or it includes all Pennsylvanian rocks above the base of a prominent sandstone that is well developed at Dixon and is here called the Dixon sandstone.

Thickness. The thickness varies considerably because both of original depositional differences and because of erosional differences at the base of two sandstones of the series. The thickness varies from 250 to 400 feet with a possible maximum slightly in excess of the latter figure.

Character. The composition of the formation as a whole as well as the thickness of the individual members, may best be seen from the following section from the top downward:

Mt. Gilead sandstone	20′ to 30′
Mt. Gilead shales with thin coals and limestones that are usually thin but one of which is locally 20′ to 30′ thick	150′ to 200′
Vanderburg sandstone	10′ to 30′
Bald Hill shales	60′ to 120′
Dixon sandstone	10′ to 50′
	250′ to 430′

It is not probable that all of the members reach either their maximum or minimum thickness at any one point, so that 300 to 400 feet may be safely taken as the average thickness of the entire formation.

The Dixon sandstone forms the basal member of the formation. It is well developed in the town of Dixon, whence it takes its name. It is well exposed near the railway depot and at numerous other points both about the town and over a considerable area of the county as will be seen presently.

In character it is usually of medium grain and quite variable in structure, bedding and composition. In places it is massive and hard, in others seamed and soft. It may be without conspicuous bedding planes or may be either uniformly or cross-bedded. The grain while never very coarse varies from medium to fine. It may become argillaceous and may even include a shale parting, as may be seen at several places in and just east of Dixon. It is equally variable in thickness and while usually 10 or 15 feet to 25 or 30 feet may in exceptional places reach 50 or 60 feet. These variations render it somewhat difficult to identify and make it easy to confuse with the overlying Vanderburg sandstone unless it has been traced continuously from place to place.

The next member of the formation is a body of shales that are usually 80 or 100 feet thick but vary from 60 to 120 feet in places. These shales include several thin coals in their lower part usually in association with thin limestone. In their upper part there are several thin coals with in some places a con-

spicuous black shale and at one place a limestone that reaches several feet in thickness. The shales are dominantly argillaceous and marly and usually leaden or green in color with a hint in some places of a purplish mottling. They often form steep slopes that are either bare or support a scant growth of blackjack and other scrub timber. In the more marly phases nodules or thin layers of impure limestone or iron carbonate may be locally developed, and in some of the concretionary nodules on the bald hill just east of Dixon, whence the shale takes its name, small masses of fluorspar and of lead and zinc sulphides, galena and sphalerite, may be found.

Other excellent exposures are found on the steep slopes that lead up to the town of Vanderburg, especially those on the west side. In places thin sandstones develop in this shale and become difficult to distinguish from the Dixon sandstone. This is especially true northwest of Dixon where such sandstones are well developed on the head waters of Craborchard and Caney creeks and are usually associated with thin coals, especially along both the eastern and northern branches of the latter creek.

In the upper part of these shales there is apt to be a thin coal overlaid in places with a few inches of marly shale or limestone that contains marine fossils. In places this coal is just beneath the Vanderburg sandstone while in other places it is absent, apparently because of erosion prior to the deposition of the overlying sandstone. This thin coal may be seen south of Catesville at locality 29 where an attempt has been made to work it at water level on the east bank of Deer creek.

The Vanderburg sandstone overlies the Bald Hill shales and constitutes the third member of the formation. It underlies the crest of the ridge on which Vanderburg is situated and is named from there. It is usually 15 to 30 feet thick tho in places northeast and east of Vanderburg it possibly becomes somewhat thicker. Near Slaughtersville it may be 40 to 60 feet thick. It is medium to coarse grained and is usually soft so that it presents rounded sloping surfaces instead of precipitous cliffs. It is well developed along the ridge crest south of Vanderburg to the county line and to the east a pronounced dip carries its base down about to water level on the east side of Deer creek. Farther eastward it again rises above drainage level at Slaughtersville

and northeast of there is found on the ridge crest for some miles along the county line. North and northwest of Catesville it seems to lie quite close above the Dixon sandstone and has probably cut out most of the intervening Bald Hill shales there and the same is true about Mt. Pleasant church. North of Dixon it occurs for some miles at intervals along the Harpshead road. It is so nearly alike the Dixon sandstone that the two may be easily confused.

Above the Vanderburg sandstone there are 150 to 200 feet of shales very similar to the Bald Hill shales in character and hence easily confused with them. These shales become sandier in their upper 25 to 50 feet and weather to a rusty yellow, as may be seen in the immediate vicinity of Mt. Gilead school, but their middle and lower parts are argillaceous and calcareous with thin limestone in places.

Two miles southwest of Mt. Gilead at locality 30 one of the limestones becomes 20 to 30 feet thick and has formed a number of pronounced sink holes near the home of Mr. T. H. Brown. A thin coal occurs close beneath this limestone in places, and has been opened a mile east of Mt. Gilead down near water level, and along the branch in the intervening distance black shale is prominently developed at about three horizons eight to twelve feet apart.

The Mt. Gilead shales become sandy near the top and end above in a soft sandstone that may reach 20 or 30 feet in thickness in the small area around and on the ridge west of Mt. Gilead school where it is known to occur. It is believed to be stratigraphically the highest portion of the Pennsylvanian rocks found in Webster county and may be called the Mt. Gilead sandstone.

The limestones are earthy or brecciated and are thin and inconspicuous except in the one place above noted in the upper part of the formation and even there the thickening is purely local. Exposures of any of these thin limestones are rare and are never found except along road cuttings or in the deeper gullies or smaller streams that are actively cutting down their channels.

The coals of the formation are thin and not even of remote value, although they are frequently accompanied by a conspicu-

ous black shale that on a weathered outcrop easily leads to the hope that it may be workable coal if driven in some distance. One of the most conspicuous of such horizons occurs in the Bald Hill shales on the head waters of Caney creek northwest of Dixon, where numerous openings have been made. At one of these at locality 31 there are six inches of bird's eye cannel, the only place where such coal was noted.

Divisions. The Dixon formation lends itself, as has been seen, to separation into subordinate members more readily than any of the preceding formations and has all been thus separated and named as given on page 118.

Areal Distribution. The Dixon formation crosses the central part of the county from northwest to southeast in a broad belt that coincides with the area of the Dixon upland This upland in fact owes its existence to the protection from erosion afforded about its margin by the Dixon sandstone, the basal member of the formation, as shown in plate No. 10.

The areal outcrop also occupies the axial portion of the broad flat-bottomed Webster syncline, as will be seen when discussing structure. The rocks on either side of the area dip gently inward toward the medial portion where the beds are essentially horizontal.

Economic Materials. The only material of economic value in the Dixon formation is the sandstone which in some places is suitable for structural purposes and in others is so soft and loose that it may be readily dug with a shovel and used for building sand.

Pliocene.

Lafayette Formation. In a few places in the northeastern part of the county there are some remnants of a doubtless once much more extensively developed deposit of water-worn gravel. It consists mostly of yellow chert but has some vein quartz pebbles, cemented in part with crusts of sand or clay ironstone. The pebbles are one to three inches in diameter and are well rotted by long exposure while the entire mass is well oxidized. The remnants are on or close beneath the tops of hills that border the Green river lowland and are covered by 10 or 15 feet of surface loam. Their age is not definitely known but from

their topographic position, lithologic character and state of weathering and cementation they are provisionally referred to the Lafayette formation. For the conditions of their formation see page 32.

Pleistocene.

Graves Creek Formation. The broad flat lowlands of Tradewater and Green rivers and of their principal tributaries are underlaid with fine clay, sand and gravel to depths that are known to reach 100 to 175 feet. On Graves creek a well penetrates 104 feet of such clay without reaching its base. Most of this material is a fine, dark clay that in places is soft and mucky. Wells sunk in the valleys of these streams may go nearly to the bottoms of them before finding material coarse enough to yield a supply of water. This coarser part is described as being river sand and gravel and is said in some places to contain fresh water shells. Logs are occasionally struck in it. It seems certain that some, at least, of the finer part of this material was deposited when the streams were ponded, but not enough is known of the detailed structure of the deposit to be able to give the history of the deposit in any great detail or to say what part may be lake and what river deposit.

At a few places, especially in the lower part of the valley of Deer creek—as for example at locality 21 south of Sebree—in the Green river flats east of Onton, and at Gold's on Crab Orchard creek the surface part of this valley filling contains small well rounded chert or quartz pebbles either scattered sparingly through the clay or in compact beds one to two feet in thickness. It is thought probable that this pebbly material was deposited by the melting of floating ice which may have drifted in from the Ohio river during a ponded stage in the closing days of the glacial period.

The larger part of this formation is believed to be older than the next formation, but it is probable that the surface part of this may be contemporaneous with the next which is essentially an upland formation in its typical development but which it is believed laps down the slopes and merges with some of the finer silts on the present lowlands.

Union Formation. The upland surface of almost the entire county is covered with a mantle of fine brownish loam that is

usually from eight to fifteen or twenty feet thick in Webster county. Near the Ohio river, especially in Union county, it is somewhat thicker and has the character of a typical loess with its land shells, peculiar texture and other usual features of loess. As one recedes from the Ohio river it gradually changes from a typical loess to a soft yellowish or brownish loam. This loess or loess-loam very completely mantels the uplands and effectually conceals the underlying rocks almost everywhere except in road cuttings, gullies and the active headwaters of the streams. It makes geological work a matter of great difficulty. It is named from Union county where it is usually a typical loess. On the geological map no attempt has been made to represent it.

Recent Alluvium. During floods the stream valleys are today receiving large amounts of alluvial material from the eroding uplands. Most of this is deposited near the foot of the steep slopes so that the upper reaches of the streams within and about the margin of the uplands are aggrading or filling up their valleys with material much of which comes from the gullies that scar the face of worn out and abandoned upland fields.

Formations Not Exposed at the Surface.

Beneath the Leitchfield formation are lower-lying Mississippian limestones, sandstones and shales; Devonian shale; and Silurian and Ordovician rocks, the porous parts of all of which under suitable structural and other conditions may contain oil and gas. It is not possible to give the depth to any of these underlying rocks with any great accuracy but some at least of the upper ones are believed to be within reach of the drill. These are discussed in their relation to the occurrence of oil and gas in the chapter on economic geology.

CHAPTER VI.

STRUCTURE

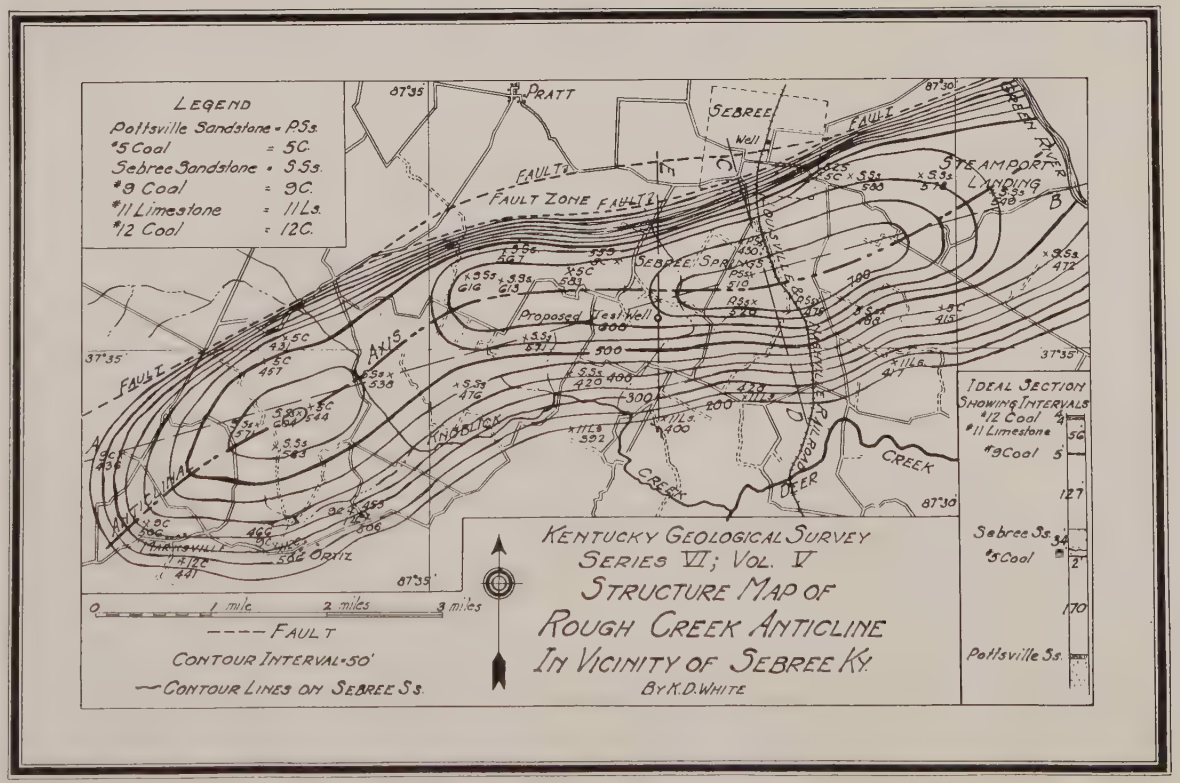
Major Features. The broad structural features of the county are simple and easily grasped. The southwestern and central part of the county is a broad structural syncline. North of this the county is crossed by an east-west line of profound faulting the western half of which line forms the northern boundary of the syncline but the eastern half is separated from the syncline by a narrow anticline that develops between the syncline and the fault. Finally, north of the fault there is a narrow belt of rocks extending to the Henderson county line and beyond that dip very gently northwestward.

Webster Syncline. The axial portion of this syncline named for the county passes through the Luzon-Dixon-Mt. Gilead region, coinciding in a general way with the median line of the Dixon upland. The trough splits near Mt. Gilead and the main prong passes slightly south of there.

From the Tradewater river, and beyond, the rocks dip gently northeastward toward this axial line. As this line is neared the dip decreases until in the bottom of the trough the rocks for some distance are almost flat and beyond the axis they rise to the northeast at first gently but finally somewhat steeply as they near either the Rough creek fault line or rise on the flank of the Sebree anticline.

The dips in the Tradewater river region average not over two or three degrees though local variations run up to four or five degrees. In the Wheatcroft-Clay region the average dip is 3 2 10% N. 35 E. or is 169 feet per mile while in the Providence region it has decreased somewhat and east of Providence it further flattens until the rocks are nearly horizontal.

On the northern side of the syncline the rocks in the Tilden region dip to the south or southwest at angles that are usually 8, 12, or 15 degrees as one nears the Rough creek fault. In the immediate vicinity of the fault, however, the dips may rise for short distances to very high angles. Some of the faulting near and west of Tilden may be normal, but most is evidently reversed. Eastward in the Marksville region the dip on the nosing

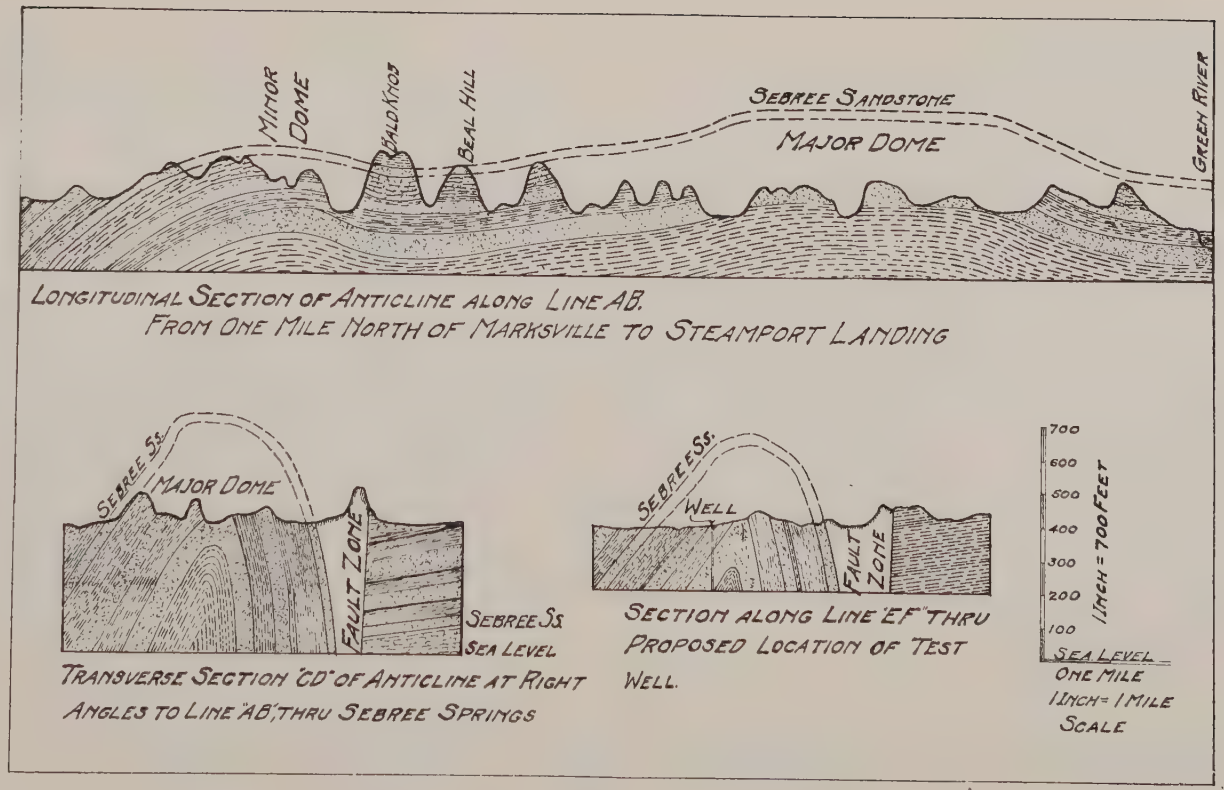


NO. 21. GEOLOGIC STRUCTURE NEAR SEBREE, KY.

point or end of the Sebree anticline, which there flattens out to the west, varies from north, through west, around to south and finally to southeast, usually at angles of 6 or 8 degrees. Eastward at Ortiz and beyond to Green river the dip is somewhat southeast at angles that are usually 10 to 16 degrees. In all cases these high dips soon flatten out greatly as one follows the direction of dip so that no very great thickness of rocks is involved in them.

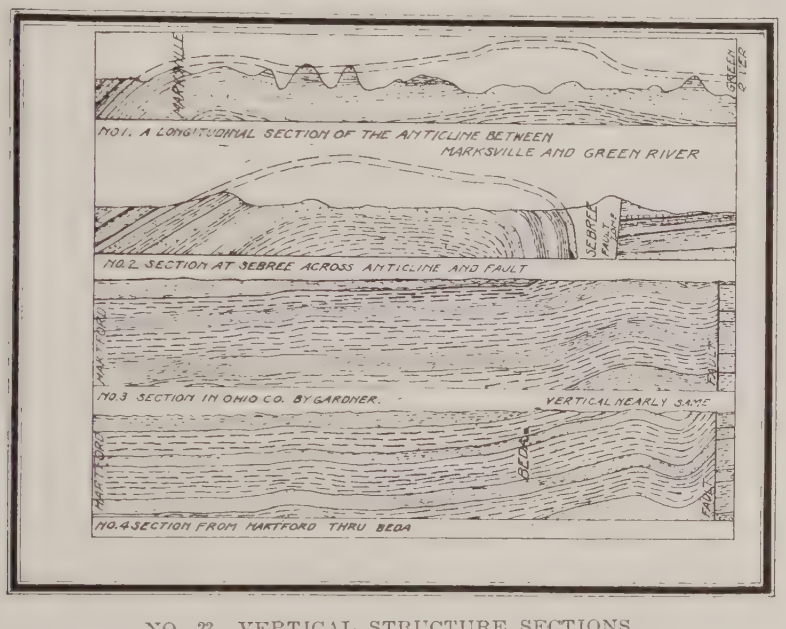
The Sebree Anticline. From Marksville east to Green river the rocks on the north side of the Webster syncline rise to a crest line and pitch down again on the north side of it forming what is here called the Sebree anticline. This anticline is long and narrow with the rocks on its axis strongly arched but not badly crushed or broken, as may be seen in plate 22. It was formed by thrust from the southeast. The axis of this anticline, as may be seen from the contoured sketch map made by Mr. K. D. White and shown here in plate 21, is not of uniform elevation but rises a half mile southwest of Sebree Springs to a dome and again shows minor doming a mile north of Ortiz. To the southwest it plunges downward and dies away north of Marksville. About a mile east of Sebree Springs the doming dies out and the axis becomes horizontal and continues so nearly to Steamport Ferry where it flattens greatly as it leaves the county. The complex topography of the Sebree hills is due to the unequal resistance that the hard Sebree sandstone and the soft shales below it offer to the erosional forces that are at work unroofing this anticline. In the domed portion about Sebree Springs the elevation and subsequent erosion have been sufficient to lay bare the upper 30 to 50 feet of the Caseyville conglomerate which forms the picturesque cliffs in that vicinity. Over much of the Sebree hills both east and west of Sebree the Sebree sandstone forms a protecting surface for the anticline. It has, however, been eaten through in many places by erosion and now forms prominent cliffs at favorable points.

The Rough Creek Fault. This is a line of profound faulting that enters the western edge of the county near Givens and pursues a somewhat zig-zag course, as may best be seen from the accompanying geological map, eastward through Tilden, the Fulcher and Melton hills, the northern part of the Sebree hills,



NO. 22. VARIOUS STRUCTURE SECTIONS IN WEBSTER COUNTY.

and the town of Sebree and crosses Green river into McLean county about a half mile south of Eastwood Ferry. In some parts of its course the fault is a simple overthrust from the south, but in others the overthrust was attended by block faulting and this latter feature is responsible for the zig-zag course of the fault line. Only at certain points where the slopes are steep can the faulting be detected. Where the surface is relatively flat the blanket of brown loam entirely conceals it so that it is not certain that the faulting forms a continuous line across the county. Where the same formation occurs on both sides of the fault, as for some distance west of Tilden and south



NO. 23. VERTICAL STRUCTURE SECTIONS.

of Wanamaker, the rocks on the south side have been thrust up only a few hundred feet at most, but where blocks have formed the uplift in some places has been 1,500 to 2,500 feet if not more. In places west of Tilden the fault may be of normal type with downthrow on the south. Relations here are very obscure.

Most of the faults are clean cut breaks that show little disturbance up to the very fault plane itself, though in some places the rocks are sheared and slickensided and in a few places crush-

ed into a breccia in which Mississippian limestones and Pennsylvanian conglomerate and shales are intimately intermixed. The disturbance and crushing seem largely confined to the rocks overthrust from the south. Those on the north side, as far as could be observed, show very little disturbance.

Lower Pennsylvanian and even Mississippian rocks are brought to the surface at intervals along the fault, as we have seen in preceding pages. Their areal extent is small but their presence is extremely helpful in the study of structural relations.

North of the Rough creek fault the rocks dip to the northwest or west northwest at the rate of not more than 20 to 40 feet per mile but are so covered with loam that detailed structural mapping is impossible.

Minor Folds and Faults.

In a few places the soft shales are found folded or crushed for a few feet or a few yards, as for instance in the deep Louisville and Nashville railway cut beneath the street bridge in Clay. Minor faults so far as known occur in sparing numbers only. The surface is so largely concealed by the loess or loam that minor faults escape detection there and the few ones known are in coal mines. In many mines such faults are unknown and where they do occur they involve displacements of from a few inches to three or four feet and are of no practical importance in the working of the mine.

Unconformities.

The Mississippian limestones are, of course, separated from the Pennsylvanian conglomerate by an uncomformity. Within the Pennsylvanian itself there are a number of unconformities, the first of which is at the base of the Sebree sandstone which in places cuts into the underlying shales. Within the Carbondale formation a minor unconformity has been described in the Clay region where a locally developed sandstone, usually some 20 or 30 feet above coal 9, cuts down across both the intervening shales and the coal itself. This seems to be confined to the vicinity of Clay, where it has caused difficulty and loss in some of the efforts made to mine coal 9. It will also be recalled that in this same Clay region there is an unconformity at the horizon of coal

NO. 24. SECTION OF THE SEBREE ANTICLINE.

11 that is responsible for the absence of this coal over a considerable area in that vicinity, and a like unconformity is of general occurrence at the horizon of coal 11 in the Sebree region. It is impossible to say in what part of the broad synclinal basin between Clay and Sebree a similar absence of coal 11 may be found.

The most important unconformity in the entire Pennsylvanian of the region occurs at the base of the Anvil Rock sandstone and may be involved in the problem of the occurrence or absence of the Baker coal. The matter as relates to this coal is by no means as clear as could be wished but must rest for the present with the statements made on pages 107 to 111. Further light can only be thrown on it by additional drill records.

At the base of the Dixon sandstone is another well marked unconformity. It, however, has no economic importance.

CHAPTER VII.

ECONOMIC GEOLOGY

Coal. Coal is the only mineral resource of the county that has so far been extensively developed, and while other materials will probably receive increased attention in the future yet it is improbable that any or all of them together will ever seriously rival coal in importance.

It has seemed best to discuss the character, thickness and quality of the coals in connection with the description of their stratigraphic and geographic position and these matters do not call for repetition and further discussion here. Certain general statements as to the coals of the county may, however, be made with advantage at this point.

The coals of the county are all bituminous except in rare cases where a few inches of cannel coal may be found as a top member of a regular bituminous seam. There is no lignite or anthracite. In physical character they are medium soft, being hard enough to yield a good percentage of lump even if shot on the solid and, of course, a larger percentage when machine mined as is done in the larger commercial mines of the county. The coals ship well and stock well except in a small area on the western end of the Sebree anticline where the coals are finely jointed by the severe deformation they have suffered. This area, however, is not of great extent and does not ship any coal. None of the seams are block coal.

While coals 9 and 11 are being coked in neighboring counties and would doubtless coke in Webster county yet the chief demand is for coal for steam, domestic and gas purposes and not for coke. The high sulphur content would render the coke unsuitable for iron furnace use, although it would be adapted to all other uses. The future for the coals of the region lies not in coking but as general steam and domestic coals.

Chemically the Webster county coals are to be compared with the other coals of the same district because these are the ones with which the Webster coals complete in all markets reached only by railway. Such markets are and will probably remain the chief users of these coals, though some are barged down the Ohio and Mississippi by the West Kentucky Coal Company.

Taking the Eastern Interior Coal Field, which includes the coals of Illinois, Indiana and Western Kentucky, it has been long known as generally true that as one goes westward, or northwestward, in this field the average moisture, ash and sulphur increase and the average volatile combustible matter and the fixed carbon decrease. In consequence the southeastern or Kentucky portion of the field is of better general quality than the remainder, as average analyses that give the true character of the coal will show.

The average of the analyses here given is believed to be fairly representative of the Webster coals as a whole and shows them to be medium low in total moisture, with an average between 4 and 5 per cent and in some less than 3 per cent. The average ash is from 7 to 9 per cent and the sulphur between 3 and 4 per cent. In each of these items they are superior to the other coals of the Eastern Interior Field, while in volatile combustile matter and fixed carbon they are decidedly superior. They also possess advantages in stocking and it is believed that there is less danger of spontaneous combustion with them.

The available area of each of the commercial coals of the county has already been outlined, but in recapitulation it may here be said that the largest and best developed area is along the outcrop belt of coals 6 to 14 in the southwestern part of the county and northeast of these outcrop lines each coal is available in a belt several miles wide before the northeastward dip carries it down beyond the depth limits of present profitable mining. In the northeastern part of the county coals 9 and 12 are available along their outcrop on the west end and south side of the Sebree anticline from Marksville east and on the north side of the Rough creek fault coal 9 should be available entirely across the county, the deepest portion of it being probably 300 to 400 feet deep in the northwestern part of the county.

In the middle of the county there is a belt some six to ten miles wide extending northwest and southeast across the county and coinciding with the Dixon upland in which the commercial coals lie 1,000 feet or more below the surface and hence are too deep for present development, although the day is not far distant when it will be practicable to sink to them anywhere within the synclinal basin. The greatest depth of coal 9 beneath drainage

level probably nowhere exceeds 1,500 feet in Webster county and this extreme depth is reached in a small area in the region around Mt. Gilead school only. Elsewhere along the axis of the Webster syncline it should be reached between 1,000 and 1,200 feet below lowland drainage level or at correspondingly increased depths, of course below the upland level.

The entire column of coal bearing rocks in the county totals practically 3,000 feet if the maximum thickness of each formation be taken. It is probable, however, that no one vertical measurement would include more than 2,500 feet in all, when variations in thickness of individual members is taken into consideration. This, however, is probably the greatest thickness to be found anywhere in the entire Eastern Interior field.

NO. 25. MINING CAMP, WEST KENTUCKY COAL CO.

In this modern camp at Mine 7, the houses are regularly spaced along wide streets.

The number of coal horizons in this 3,000 feet of rocks is not definitely known but drill records and surface sections reveal at least 40 and there are probably several additional local ones in the Caseyville and in the upper part of the Dixon. For the position of these coals in the general geological section reference should be made to Plate 4. Of these forty coals those that are of probable present economic value are coals 1B, 6, 9, 11, 12 and

14, each of which has been fully described and the area and probability of its occurrence given in preceding sections of this report. A very few of the other coals may prove here and there of local value for country use though such areas will probably be very restricted.

At a number of the larger mines excellent mining camps are maintained. A view of a part of the miners' houses at the West Kentucky Coal Co.'s Mine No. 7 is shown in Plate 25. A general view of the camp of the Diamond Coal Co. is shown in Plate 26.

NO. 26. MINING CAMP, DIAMOND COAL CO.

In this camp some of the houses are grouped into streets while others are attractively scattered along the upland crest.

Oil and Gas. Seeps of oil and gas are known at several places along the Rough Creek fault and a number of deep wells have been bored both along this fault and elsewhere in the county in the hope of finding oil. The rocks that may be penetrated by the drill here belong to the Mississippian and Pennsylvanian systems and consist of sandstones, shales and limestones. The limestones are not important as a storage reservoir for oil and may not be important as a source. Some of the shales may have furnished the organic matter from which oil may have been derived. The sandstones would furnish storage space in which any oil might accumulate. This accumulation would be governed by the structural conditions.

The following tabular classification of the formations of the Pennsylvanian and Mississippian may aid in understanding the position, thickness and age of the possible oil-bearing sandstones that might be encountered in drilling in Webster county. The Pennsylvanian is taken from the author's own work as contained in this report. The Mississippian is slightly modified from a chart given by Charles Butts[15], with thicknesses as given by Butts.

PENNSYLVANIAN.

Dixon Formation	430′
Lisman Formation	900-1000′
Carbondale Formation	230-650′
Tradewater Formation	175-700′
Caseyville Formation	200-500′

MISSISSIPPIAN.

Chester Group:	
Clore Formation	150′
Palestine Sandstone	100′
Menard Limestone	80′
Tar Springs Sandstone	150′
Glen Dean Limestone	50′
Hardinsburg Sandstone	60′
Golconda Formation	140′
Cypress Sandstone	80′
Ridenhower Shale	50′
Bethel Sandstone	60′
Ste. Genevieve Limestone	266′
St. Louis Limestone	350′
Warsaw Limestone	250′
Fort Payne Chert	550′

DEVONIAN.

Chattanooga or New Albany Shales.

The shales associated with the various sandstones found in the formations of the above table need not be discussed further than to say that some of them may have furnished organic matter for the making of oil and any of them would be impervious enough to hold in any oil that might gather in the sandstones between them.

[15] Butts, Charles; Mississippian Formations of Western Kentucky; Ky. Geol. Surv., 1917.

The Dixon formation contains the Vanderburg sandstone near its middle and the Dixon sandstone at its base. These are both either exposed at the surface so generally or are so near it in the area of their occurrence that they need not be considered as possible oil reservoirs.

The Lisman formation contains some fine grained sandstones, best known from core drill records. They outcrop on both sides of the Dixon syncline beneath the alluvial filling of the Lisman and Deer creek lowlands and probably are of no importance in relation to oil. The basal member of the Lisman is the Anvil Rock sandstone. This is coarser and more massive and might act as a reservoir rock were it not in the Webster syncline south of the Rough creek fault and either at or so near the surface on the Henderson upland north of that fault, that it could not be considered a favorable reservoir.

The Carbondale formation has only two sandstones of consequence. The higher is close above coal No. 9 and is variable in occurrence and thickness. The lower is much more persistent and regular. It is the Sebree sandstone at the base of the formation. Both these sandstones outcrop across the entire southwestern end of the county and also outcrop in the northeastern part about the Sebree dome. Structural conditions south of Rough creek fault are nowhere favorable for oil accumulation in either of these beds. Under the Henderson upland north of the fault they are found at such slight depth that there is little chance of their being of any great importance there.

The Tradewater formation consists largely of shales and has no sandstones of probable importance.

The Caseyville formation has one or two persistent sandstones or conglomerates of considerable thickness. The highest of these is exposed in the Sebree dome and at places along the Rough creek fault to the west of there. It is not likely that any coarse bed of the Caseyville would hold oil in the Sebree dome, owing to the slight cover. It does seem possible that west of there along either the south or the north side of the fault sandstones or conglomerates of the Caseyville might contain oil where structure is favorable as explained on a following page. In the Lawrenceville area in Illinois the Pottsville contains the Bridgeport sand in its upper part and the Buchanan sand at its base.

Both are massive and thick. Both contain much salt water but have oil in their upper part in areas where they are structurally high. Farther south and nearer Webster county, in the Allendale oil field in Illinois, these Pottsville sands are somewhat deeper and are filled with salt water.

Chester Group. In the tabular classification of these rocks given above, five sandstones are included. Since these rocks are not exposed in this county it is not known whether all of these sandstones occur here or not. The Palestine sandstone is thin and shaly in Crittenden county and absent in Warren county. The Tar Springs sandstone varies from massive to shaly. It gets its name from the petroleum springs that issue from its base at several points and thus show that in places at least it contains oil. It occurs rather widely, is probably present and would form a good oil sand in all probability. The Hardinsburg sandstone is described as usually thin-bedded, flaggy, argillaceous and fine grained. It would not seem promising as an oil sand. The Cypress or Big Clifty sandstone is a medium coarse grained sandstone some 40 to 80 feet thick. It may be present and should make a good oil reservoir. At the base of the Chester is the Bethel sandstone. It is described by Butts[16] as a thick bedded, coarse grained sandstone that locally contains pebbles. It is said to vary from 10 to 100 feet in thickness. It, like the Cypress, may be present and should act as a good oil reservoir.

In Illionis[17] the Chester produces oil from two prominent sands, the Kirkwood and the Tracy. The Kirkwood is the upper one and is some 200 to 250 feet below the base of the Pottsville. It varies from 0 to 35 feet in thickness. It may be split into several lenses and though irregular in detail is very persistent as a whole. It is most prolific as an oil sand, gives excellent initial production and is long lived and steady. The oil is sweet, averages 36°B. and has some gas. The Tracy sand is 90 to 130 feet below the Kirkwood and only a short distance above the base of the Chester. It is 10 to 50 feet thick. It is rather an irregular and discontinuous zone of sand lenses instead of a single continuous bed. The oil is described as high in sulphur, or "sour," and of high gravity. As an oil-bearing horizon it is of minor importance.

[16] Butts, Chas.; Loc. cit.
[17] Ill. Geol. Surv., Bull. 33, pp. 158-162, 1916.

Ste. Genevieve. A thin but very persistent sandstone occurs in this formation and if present in the rocks beneath Webster county might be porous enough to contain oil. In Illinois there is in the Ste. Genevieve the well known McClosky sand, which is described as either a thin sandstone or an oolitic limestone in a zone some 80 feet in maximum thickness in the upper part of the Ste. Genevieve. It is 100 to 125 feet below the Tracy sand in the lower part of the Chester. The initial production varies from small wells to very large ones, some starting off as gushers. The large ones have shown rapid decline. It is there a green oil with high sulphur and strong odor.

In the St. Louis, shows of oil have been gotten in a few deep holes in nearby portions of Illinois but no commercial production. In Warren and other Kentucky counties to the south and east some commercial oil is gotten from the Fort Payne, usually the lower part. It is, of course, impossible to say what may be the character of the Fort Payne in Webster county but the question has little practical importance because of the great depth to that formation.

With sandstones, as has been seen, in the Pottsville, the Chester and the Ste. Genevieve that might act as oil reservoirs in Webster county, it becomes pertinent to inquire as to the structural conditions and the presence or absence of salt water. It is generally true where oil-bearing rocks are folded into anticlines and synclines, that if water be present in the rocks the oil will be found in the anticlines with the water immediately beneath. If the water is absent, the oil will be found not up in the anticlines but down in the synclines.

In the nearby oil fields in southeastern Illinois salt water is encountered in the lower parts of the structures and immediately beneath the oil, which is in the domes and anticlines. In Webster county deep holes report salt water, so that it may safely be assumed that salt water is present in the lower parts of all of the above-mentioned sands in this region. It would accordingly not be advisable to drill in synclines. One would almost certainly strike salt water in such places. Drilling should be confined to anticlines or to such other places as have structural conditions such as to cause them to act as anticlines.

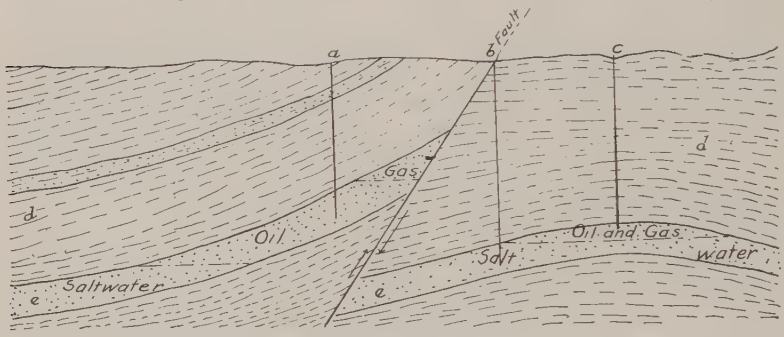
When one examines the structure of the county for anticlinal areas or anticline-like areas, he finds that the central portion of the county is crossed by the broad Webster syncline, as described on page 125. On the south side of the syncline the rocks to the Tradewater river and beyond are rising to the southwest and have no anticlinal, terraced, or faulted structure that would arrest the movement of oil and allow it to accumulate. Neither the Webster syncline nor any part of the county south of it is regarded, therefore, as holding any promise of being oil-bearing territory.

On the north side of the Webster syncline, conditions are different, however. As the rocks rise to the north from beneath the synclinal trough they approach the Rough creek fault—which, it will be remembered, was caused by an overthrust from the south through most of its extent, at least, and are either arched up into an anticline as at Sebree with a fault on its north side or are turned up and broken off along a fault plane.

The structure of the Sebree anticline is given graphically in plate 21 by Mr. K. D. White and is explained on page 127. Locations with favorable structure exist along the highest places in this dome as shown by the structure contours. The greatest element of uncertainty in locating a drilling site on this Sebree anticline arises from the fact that the inclination of the fault plane bounding the area on the north is not known. It is overthrust from the south and this often means that the fault plane dips south at a low instead of a steep or high angle. The well 3,200 feet deep, drilled on the crest of the arch just south of Sebree Springs, may have been near enough to the fault plane to intersect it somewhere in its lower part if the fault plane had a low inclination or may have been entirely south of it if the inclination was high. Nothing in the fragmentary log of the well as published on page 170, shows whether the fault was encountered or not. This well got gas and such a good show of oil that it was shot in the belief that it would make a producer. Information is lacking as to whether the shot was so heavy as to crush and powder the sand and seal the pores, or to break the rock through to some nearby salt water. Salt water is today flowing from the hole. Whether it came in from the bottom

sand as a result of the shot or from some higher sand when casing was pulled, or has eaten through the one string of casing now in the hole is not known.

It is not believed that this one hole has thoroughly tested the Sebree anticline. Perhaps the most favorable place for further testing is in the western part, northeast of Marksville.



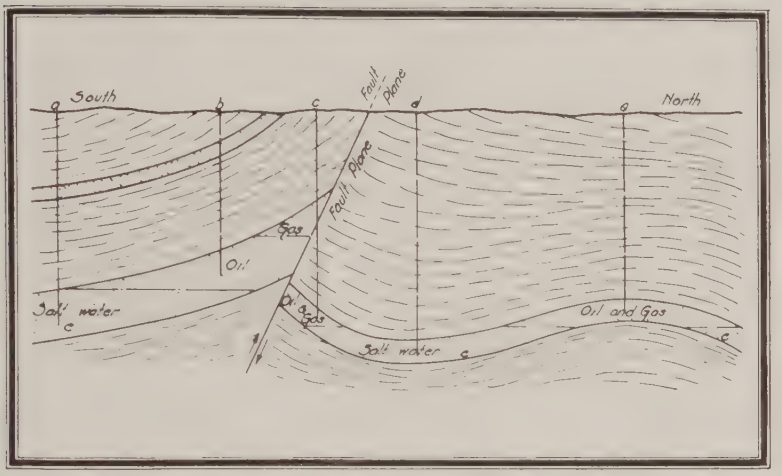
NO. 27. FAULT STRUCTURE AND OIL POSSIBILITIES.

Where the Rough Creek fault plane is sealed, oil may accumulate in porous sandstone on either side of the fault as here indicated. Wells at a and c would obtain oil; at b, only salt water.

It might be well to drill several hundred yards south of the highest point of the structure there in order to run less risk of drilling through the Rough creek fault plane, whose position is indicated on the north, but whose inclination is unknown.

Rough Creek Fault Structure. A second kind of structure that may be favorable to oil accumulation exists along the Rough creek fault and is illustrated in Plates 27 and 28. Pennsylvanian and Mississippian rocks rise northward from the Dixon syncline and their broken edges abut against the fault as shown in these two plates, where it is assumed that any oil or gas is sealed in along the fault plane. If any of the porous sandstones contain oil, gas and water, they will be arranged as given in these figures and wells located on the south side of the fault would reach one or the other of these three substances according to their location and the distance beneath the surface to the reservoir bed.

South Side of Fault. Since the rocks on the south side of the fault are largely covered with loam or alluvium, and the thickness of the various formations there is not definitely known, it is not possible to say just how deep any given probable oil



NO. 28. FAULT STRUCTURE AND OTHER OIL POSSIBILITIES.

This shows alternative structural possibilities along the Rough Creek fault as compared with the preceding cut. Oil may occur south of the fault at well b, and the folding north of the fault may cause oil to occur at wells c and e; wells a and d would get only salt water.

sand there would be. The dip of the fault plane is also unknown, though it is probable that it is very nearly vertical since the faulting is largely of the block type, but with some upturning on the south. One should locate a third to a half mile south of the fault and should be prepared to sink more than one hole, if any thorough test is planned. So many unknown factors are involved that a first well might easily be too high or too low on the structure, but would be valuable as a guide to a better location for a second well. In drilling so near a fault it would be especially desirable to keep as complete and accurate a log as possible and preserve a full set of samples of the cuttings. These when carefully studied would show what strata were passed through and throw much light on the structure. Oil on this south side of the fault would gather from the north half of the adjacent Webster syncline.

North Side of Fault. On the north side of the fault either of two alternative structural conditions might be found. Either the rocks on the north side of the fault may have been arched upward so as to form an anticline a slight distance north of the fault as in Plate 27, and have a downward inclination where they abut against the fault plane or they may turn up against

the fault plane as in Plate 28 and may then either again rise into an anticline somewhat farther north as also shown at E in Plate 28 or from the fault plane they may continue to dip gently north for some distance and finally flatten out without rising to an anticline at all. Of the two conditions, the greater hazard would be taken in drilling to strike the oil that might be just against the fault plane, as at C Plate 28. It is believed that a better chance for striking oil north of the fault is found in anticlinal locations some distance away from the fault, as in Plate 27, rather than close against it. In order to determine just how far north of the fault to make a location very careful search would have to be made for any outcrops that would help determine the position of any anticline that may exist there. Loam and alluvium again interfere very much in making such determinations. In the absence of sufficient surface exposures and of numerous bore holes in the region north of the Rough creek fault it has been impossible to contour its structure. Any oil found north of the fault would gather from the large area to the north and west where the regional dip is to the northwest.

Shale and Clay. There is almost everywhere an abundance of shale and clay for brick and tile making and such industries could be developed without limit. There are a few yards that make drain tile and ordinary brick from the surface loam or alluvial clays but no shale brick are made in the county, although there is an abundance of suitable material adjacent to present transportation lines and near a local coal supply in almost any one of the Pennsylvanian formations.

Fireclay. While tests and special studies have not been made of the underclays yet it seems probable that some of them, especially that beneath coal number 7, would prove to be fireclays of value.

Building Stone. The many sandstones of the county contain much material that might be used for rough building stone. They are the usual type of light colored coal measure sandstone, variable in texture and coloring and include some materials of good quality. The only quarry in the county is a small one two miles east of Sebree, where stone is gotten out for local use for foundations and chimneys.

Limestones. These are sometimes used for rough foundations, though generally little or no attention is paid to their use. The Mississippian ones alone are probably pure enough to burn for lime and their disturbed structure and very restricted areal development in the county make them a practically negligible quantity for economic purposes. It seems in many places that the thicker limestone ledges, especially those over coal 11, might be crushed and used to advantage in building roads. Such beds would furnish the best material to be had in the county for such purposes. The various thin limestones in the county would in the aggregate furnish a large part of it with good road material and would find their highest usefulness when so used.

Sand. On the uplands and about their margins sand for local use may be obtained at numerous places. It is not found on the lowlands. In a few places the Vanderburg and Dixon sandstones are disintegrated to a soft loose mass that may readily be used for building sand, while any of the thicker more persistent sandstone might readily be crushed for this purpose.

CHAPTER VIII.

LOGS OF WELLS AND SHAFTS

West Kentucky Coal Co.—Short hole on main entry, Mine No. 4, Wheatcroft. Elevation of surface 385'. Locality 114.

This and the following log are shown graphically in Plate 22.

6′		Clay	0′	to	6′	
7′		Clay and gravel	6′	to	13′	
2′		Soapstone	13′	to	15′	
	8″	Coal	15′	to	15′	8″
6′	4″	Fire clay	15′	8″ to	22′	0″
7′		Sandrock	22′	to	29′	
2′		Soapstone	29′	to	31′	
2′		Sandrock	31′	to	33′	
1′		Gray slate	33′	to	34′	
3′	10″	Coal—Baker or No. 14	34′	to	37′	10″
2′	2″	Fire clay	37′	10″ to	40′	
1′	6″	Limestone	40′	to	41′	6″
4′	6″	Fire clay	41′	6″ to	46′	
5′		Sandrock	46′	to	51′	
7′		Soapstone	51′	to	58′	
2′	6″	Sandrock	58′	to	60′	6″
2′	6″	Gray shale	60′	6″ to	63′	
2′		Lime rock	60′	to	65′	
3′		Soapstone	65′	to	68′	
2′		Coal	68′	to	70′	
2′	6″	Fire clay	70′	to	72′	6″
9′	6″	Limestone	72′	6″ to	82′	
	6″	Gob	82′	to	82′	6″
	6″	Black slate	82′	6″ to	83′	
1′		In No. 11 coal	83′	to	84′	

West Kentucky Coal Co.—Hole 2900′ N. E. of Short Hole, Mine No. 4, Wheatcroft. Elevation of surface 385′. Locality 115.

This and the preceding log are shown graphically in Plate 22.

3′	Clay	0′	to	3′
4′	Quicksand	3′	to	7′
8′	Red sand rock	7′	to	15′
8′	Gray sand rock	15′	to	23′
16′	Soapstone	23′	to	39′
27′	White sand rock	39′	to	66′
8′	Soapstone	66′	to	74′
7′	Gray slate	74′	to	81′

	6″	Coal	81′		to	81′	6″
1′	6″	Fire clay	81′	6″	to	83′	
2′		Limestone	83′		to	85′	
6′		Fire clay	85′		to	91′	
8′	6″	Sandy shale	91′		to	99′	6″
2′	6″	Coal—Baker No. 14	99′	6″	to	102′	
4′		Fire clay	102′		to	106′	
14′		Sandrock	106′		to	120′	
5′		Gray slate	120′		to	125′	
11′		Sandy shale	125′		to	136′	
9′		White sandrock	136′		to	145′	
3′		Soapstone	145′		to	148′	
7′		Limestone	148′		to	155′	
3′		Black slate	155′		to	158′	
5′	6″	Coal—No. 11	158′		to	163′	6″
		Fire clay	163′	6″	to	164′	

Bore No. 1.—Blackwell Coal & Mining Co., Edmonston property, one and one-half miles southwest of Clay and one thousand(?) feet east of Providence road. Locality 70.

Elevation of mouth 382.8 feet. Date, October 17th, 1903.

18′		Dirt	0′		to	18′	
10′		Black sandstone	18′		to	28′	
42′		Gray slate	28′		to	70′	
5′	5″	Black slate	70′		to	75′	5″
5′		Coal No. 9	75′	5″	to	80′	5″

Bore No. 2.—Blackwell Coal and Mining Company, Aldridge property, in Clay near public school. Elevation of mouth, 359.3 feet. Date, January 5th, 1904. Locality 71.

6′		Dirt	0′		to	6′	
29′		Sandstone	6′		to	35′	
1′		Clay	35′		to	36′	
22′		Soapstone	36′		to	58′	
9′		Soapstone and clay	58′		to	67′	
1′		Coal	67′		to	68′	
19′	5″	Fire clay and soapstone	68′		to	87′	5″
4′	8″	Coal (Baker coal)	87′	5″	to	92′	1″
12′	2″	Fire clay	92′	1″	to	104′	3″
54′		Soapstone	104′	3″	to	158′	3″
11′		Sandstone	158′	3″	to	169′	3″
42′		Gray slate and sandstone	169′	3″	to	211′	3″
41′		Gray slate	211′	3″	to	252′	3″
3′		Black slate	252′	3″	to	255′	3″
5′		Coal No. 9	255′	3″	to	260′	3″
		Fire clay					

Bore No. 3.—Blackwell Coal & Mining Company, Edmonston farm, on flat 45′ from Crab Orchard Creek, 1000′ west of L. & N. Railroad bridge and north of present shaft of Clifty Consolidated Coal Company near Clay. Locality 72.

Elevation, 351.4 feet. Date, August 16th, 1906.

40′	Dirt and quicksand	0′	to	40′	
5′	Soft sandstone	40′	to	45′	
4′ 2″	Gravel and mud	45	to	49′	2″
9′ 10″	Dark, coarse sandstone	49′ 2″	to	59′	
21′	Gray slate	59′	to	80′	
2′ 4″	Black slate	80′	to	82′	4″
4′ 10″	Coal No. 9	82′ 4″	to	87′	2″
	Fire clay				

Bore No. 4.—Blackwell Coal & Mining Company, Edmonston farm, about 2000 feet southeast of Bore No. 3 above, near present shaft of Clifty Consolidated Coal Company and about 8′ below the horizon of No. 11 coal. Elevation 370.3 feet. Date, September 6th, 1906. Locality 73.

8′	Loose rock and dirt	0′	to	8′	
6′	Sandstone	8′	to	14′	
10′	Soapstone	14′	to	24′	
9′ 8″	Dark gritty shale	24′	to	33′	8″
1′	White sandstone	33′ 8″	to	34′	8″
12′ 8″	Dark gritty sandstone	34′ 8″	to	47′	4″
24′	Gray slate	47′ 4″	to	71′	4″
2′ 4″	Black slate	71′ 4″	to	73′	8″
4′ 10″	Coal No. 9	73′ 8″	to	78′	6″

Bore No. 5.—Blackwell Coal & Mining Company on Hicks land, about one mile due west of No. 4 above. Elevation 395.4 feet. Date, May 27th, 1907. Locality 74.

8′	Dirt	0′	to	8′	
12′	Dirt and broken rock	8′	to	20′	
12′	Soft soapstone	20′	to	32′	
23′	Gray slate	32′	to	55′	
2′	Black slate	55′	to	57′	
4′ 10″	Coal No. 9	57′	to	61′	10″
	Fire clay				

Old Blackwell shaft in Clay, depth 245′ to top of No. 9 coal by one informant; another party says it was 251′ to top of the coal. Elevation of mouth 398.25 feet. Locality 75.

New Blackwell shaft, now Clifty Consolidated Coal Company, one mile south of Clay. Elevation 363.75 feet. Depth to top of No. 9 coal 70 feet. Locality 88.

Korf shaft, northeast edge of Clay. Elevation about 356 feet. Locality 17.

20′		Dirt	0′		to 20′	
15′		Shale with thin sandstone	20′		to 35′	
0′	1″	Coal	35′		to 35′	1″
94′	11″	Sandstone, last 10′ shaly	35′	1″	to 130′	
5′		Soapstone	130′		to 135′	
8′		Gray slate	135′		to 143′	
4′		Black slate	143′		to 147′	
0′	6″	Coal, thinning to 3″ on one side	147′		to 147′	6″
0′	3″	Fire clay	147′	6″	to 147′	9″
2′	3″	Hard sandstone	147′	9″	to 150′	
15′		Bastard sandstone (argillaceous?)	150′		to 165′	

Drilled 130′ farther in bottom of shaft, striking 6′ of very hard limestone at a depth of 254′ from surface, and beneath it was about 1″ of good coal. No further coal struck. Total depth 295′.

Baker Bore No. 1.—Between Baker shaft and Wheatcroft, at curve on railroad. Elevation 361.6 feet. Locality 76.

2′		Soil	0′		to 2′	
7′	2″	Gravel	2′		to 9′	2″
26′	7″	Sandstone	9′	2″	to 35′	9″
6′	3″	Limestone	35′	9″	to 42′	
0′	5″	Black slate	42′		to 42′	5″
5′		Coal No. 11	42′	5″	to 47′	5″
2′	1″	Fire clay	47′	5″	to 49′	6″
11′		Sandstone	49′	6″	to 60′	6″
1′		Fire clay	60′	6″	to 61′	6″
3′	6″	Soapstone	61′	6″	to 65′	
2′	6″	Coal No. 10(?)	65′		to 67′	6″
1′	6″	Fire clay	67′	6″	to 69′	
2′	6″	Sandstone	69′		to 71′	6″
0′	6″	Fire clay	71′	6″	to 72′	
3′	6″	Gray sandstone	72′		to 75′	6″
2″	6″	Clay and slate, mixed	75′	6″	to 78′	
10′	6″	Slate, mostly	78′		to 88′	6″
10′	8″	Sandstone, black	88′	6″	to 99′	2″
0′	1″	Coal	99′	2″	to 99′	3″
1′	9″	Fire clay	99′	3″	to 101′	
2′		Sandstone, black	101′		to 103′	
1′		Slate	103′		to 104′	

12′	Black sandstone	104′		to	116′	
30′	Gray slate and soapstone, some clay	116′		to	146′	
4′ 6″	Hard black slate	146′		to	150′	6″
4′ 6″	Coal No. 9	150′	6″	to	155′	

Baker Bore No. 2.—Frier farm, three-fourths of a mile southwest from Baker shaft. Elevation, 375.2 feet. Locality 77.

4′	Soil	0′		to	4′	
14′	Gravel	4′		to	18′	
21′	Gray sandstone	18′		to	41′	
3′	Black sandstone, slate, and a trace of coal	41′		to	44′	
32′ 6″	Gray slate	44′		to	76′	6″
3′ 6″	Black slate	76′	6″	to	80′	
4′ 10″	Coal No. 9	80′		to	84′	10″
	Fire clay					

Baker Bore No. 3.—W. P. Henry farm, a half mile southwest of No. 2 above. Elevation, 391.6 feet. Locality 78.

3′	Soil	0′		to	3′	
13′ 10″	Gravel	3′		to	16′	10″
8′ 2″	Sandstone	6′	10″	to	25′	
18′ 6″	Gray slate	25′		to	43′	6″
2′ 6″	Black slate	43′	6″	to	46′	
4′ 10″	Coal No. 9	46′		to	50′	10″
	Fire clay					

Baker Bore No. 4.—Sidney Hill farm, 150 yards east of present Baker shaft, used as water well. Elevation, 365.2 feet. Locality 79.

8′	Clay	0′		to	8′	
0′ 4″	Rotten coal	8′		to	8′	4″
0′ 2″	Fire clay	8′	4″	to	8′	6″
7′ 6″	Red sand with lumps of red sandstone	8′	6″	to	16′	
6′ 6″	Sands, red mixed with some white sand	16′		to	22′	6″
35′ 6″	Soapstone	22′	6″	to	58′	
1′ 6″	Gray slate and soapstone	58′		to	60′	6″
1′ 6″	Coal	60′	6″	to	62′	
3′	Fire clay	62′		to	65′	
16′	Sandstone	65′		to	81′	
16′	Soapstone	81′		to	97′	
3′	Gray sandstone	97′		to	100′	
3′	Gray slate	100′		to	103′	
2′	Black slate	103′		to	105′	
7′	Coal, Baker or No. 14 coal	105′		to	112′	

2′		Fire clay	112′		to 114′	
6′		Limestone	114′		to 120′	
0′	4″	Coal	120′		to 120′	4″
1′	2″	Fire clay	120′	4″	to 121′	6″
1′	6″	Soapstone	121′	6″	to 123′	
1′	6″	Limestone	123′		to 124′	6″
0′	2″	Coal	124′	6″	to 124′	8″
0′	4″	Fire clay	124′	8″	to 125′	
12′		Limestone	125′		to 137′	
3′		Blue fire clay	137′		to 140′	
12′		Soapstone	140′		to 152′	
12′	6″	Gray sandstone	152′		to 164′	6″
19′	6″	Dark slaty soapstone, last 2′ gritty	164′	6″	to 184′	
6′		Dark shaly sandstone	184′		to 190′	
31′	1″	Gray slate	190′		to 221′	1″
2′	9″	Black slate	221′	1″	to 223′	10″
5′	2″	Coal, No. 9	223′	10″	to 229′	
2′	8″	Fire clay	229′		to 231′	8″
		Limestone				

Log of shaft of Baker or No. 5 mine of West Kentucky Coal Co., given from memory. Compare Bore No. 4 on Sidney Hill farm on the same level and only 150 yards to the east. Elevation, about 360 feet. Locality 66.

12′		Soil	0′		to 12′	
4′		Hard pan, tough clay	12′		to 16′	
6′		Quicksand and blue muck	16′		to 22′	
6′		Yellow clay	22′		to 28′	
2′		Sandy, shaly rock	28′		to 30′	
1′	2″	Coal	30′		to 31′	2″
4′		Fire clay	31′	2″	to 35′	2″
47′		Gray sandy shale, soft at top, with hard streaks of sandstone to the bottom	35′	2″	to 82′	2″
1′	6″	Underclay	82′	2″	to 83′	8″
6′	6″	Coal, Baker, No. 14	83′	8″	to 90′	2″
3′		Thin, flaky, carbonaceous shale	90′	2″	to 93′	2″
7′		Underclay	93′	2″	to 100′	2″
15′		Limestone boulders in soft clay, grading into next lower item	100′	2″	to 115′	2″
12′		Limestone	115′	2″	to 127′	2″
51′		Gray sandy shale	127′	2″	to 178′	2″
30′		Gray shale	178′	2″	to 208′	2″
3′		Black slate	208′	2″	to 211′	2″
4′	4″	Coal, No. 9	211′	2″	to 215′	6″
1′		Very hard underclay	215′	6″	to 216′	6″

Fairmont Bore, 150 yards northwest of Fairmont mine tipple. Well mouth about 40 to 50 feet below the horizon of No. 9 coal and about 354 feet above sea level. Record fragmentary; as here given it is a composite of two somewhat different logs each given from memory, but agreeing as to the two lower coals. Locality 80.

35′	Blue mud	0′	to 35′
	Sandstone and		
	Shale with		
	Very thin coal at depth of	64′	
	No record down to		
18″	Black slate	112′ 6″	to 114′
14″	Coal	114′	to 115′ 2″
	Light underclay		
40′ or 50′	Dark sandstone		
60′ or 70′	Soapstone		
3′ 6″ or 4′	Coal, No. 6	225′ or 225′ 6″	to 229′

Lige Cullen Bore Hole on old Goben place, three-fourths of a mile northwest of Fairmont mine. Elevation of surface about 352 feet. Record from memory. Locality 81.

50′	Alluvium	0′	to 50′
4″	Hard limestone	50′	to 50′ 4″
1′	Black slate	50′ 4″	to 51′ 4″
4″	Coal	51′ 4″	to 51′ 8″
2′	Underclay	51′ 8″	to 53′ 8″
4″	Quicksand	53′ 8″	to 54′
61′	Gray shale	54′	to 115′
13′	Very dark hard slate or soapstone	115′	to 128′
4′	Black slate	128′	to 132′
4′ 8″	Coal, No. 6	132′	to 136′ 8″

Log of Air Shaft at No. 6 mine of West Kentucky Coal Co., at Wheatcroft. Elevation, 401′. Locality 34.

16.4′	Surface dirt	0′	to 16.4′
4.6′	Black slate	16.4′	to 21′
5.25′	Coal, No. 11	21′	to 26.25′
2′	Underclay	26.25′	to 28.25′
16.25′	Gray sandy shale	28.25′	to 44.5′
14.5′	Gray sandsone	44.5′	to 59′
0.9′	Black slate	59′	to 59.9′
10.1′	Soft gray sandstone	29.9′	to 70′
15′	Sandy gray shale	70′	to 85′
19′	Dark gray slate	85′	to 104′
3′	Black slate	104′	to 107′
4.5′	Coal, No. 9	107′	to 111.5′

Hoisting shaft of mine No. 7, West Kentucky Coal Co., one and one-half miles norhwest of Clay. Elevation, 385′. Locality 67.

21′	Surface earth	0′	to	21′
7′	Soft gray sandstone	21′	to	28′
18′	Gray-blue shale	28′	to	46′
1.6′	Very soft black slate	46′	to	47.6′
1.1′	Gray-brown limestone	47.6′	to	48.7′
5.1′	Soft black slate	48.7′	to	53.8′
2.1′	Underclay	53.8′	to	55.9′
1.3′	Limestone	55.9′	to	57.2′
0.9′	Gray sandy shale	57.2′	to	58.1′
1.6′	Limestone	58.1′	to	59.7′
1′	Underclay	59.7′	to	60.7′
1′	Limestone	60.7′	to	61.7′
28′	Gray sandstone	61.7′	to	89.7′
90.4′	Gray shale	89.7′	to	180.1′
2′	Black slate	180.1′	to	182.1′
1.16′	Coal	182.1′	to	183.26′
3.5′	Underclay	183.26′	to	186.76′
24′	Sandy shale	186.76′	to	210.76′
6′	Gray slate	210.76′	to	216.76′
2.5′	Soapstone	216.76′	to	219.26′
7.5′	Coal, Baker coal, No. 14	219.26′	to	226.76′
7′	Underclay	226.76′	to	233.76′

Air shaft of mine No. 7, West Kentucky Coal Co., one and one-half miles northwest of Clay, on approximately same level as hoisting shaft just given and 60 yards distant from it, given here to show the variation especially in the limestone and red and black shales in such a short distance.

17′	Surface clay	0′	to	17′
7′	Soft brown sandstone	17′	to	24′
12′	Gray-blue shale	24′	to	36′
1.1′	Limestone	36′	to	37.1′
5′	Red mottled shale	37.1′	to	42.1′
8.77′	Gray sandstone	42.1′	to	50.87′
5′	Gray slate	50.87′	to	55.87′
1.5′	Limestone	55.87′	to	57.37′
20.9′	Sandstone	57.37′	to	78.27′
95′	Gray shale	78.27′	to	173.27′
3′	Black slate	173.27′	to	176.27′
1.2′	Coal	176.27′	to	177.47′
3.5′	Underclay	177.47′	to	180.97′
25′	Sandy shale	180.97′	to	205.97′

6′	Gray slate	205.97′ to 211.97′
2.5′	Soapstone	211.97′ to 214.47′
7.5′	Coal, Baker No. 14	214.47′ to 221.97′
6′	Underclay	221.97′ to 227.97′

Bore No. 2, West Kentucky Coal Co. Elevation of surface 359 feet. Locality 59.

21′	Surface clay	0′ to 21′
45′	Gray shale	21′ to 66′
27′	Gray slate	66′ to 93′
1′	Coal	93′ to 94′
38′	Gray shale	94′ to 132′
7′	Coal, Baker or No. 14	132′ to 139′
3′	Underclay	139′ to 142′
3′	Variegated shale	142′ to 145′
18′	Flint rock (limestone?)	145′ to 163′
18′	Gray shale	163′ to 181′
37′	Sandstone	181′ to 218′
36′	Dark shale	218′ to 254′
4′	Coal, No. 9	254′ to 258′
2′	Underclay	258′ to 260′

Bore No. 8.—West Kentucky Coal Co., 8,400 feet north of Clay. Elevation of surface 358 feet. Locality 60.

52′	Surface clay	0′ to 52′
20′	Clay shale	52′ to 72′
10′	Red clay shale	72′ to 82′
18′	Gray shale	82′ to 100′
4′	Red clay shale	100′ to 104′
13′	Sandstone	104′ to 117′
112′	Gray shale	117′ to 229′
2′	Black slate	229′ to 231′
1.25′	Coal	231′ to 232.25′
3.5′	Underclay	232.25′ to 235.75′
29.25′	Sandy shale	235.75′ to 265′
1.42′	Dark soapstone or gob	265′ to 266.42′
7.08′	Coal, Baker or No. 14(?)	266.42′ to 273.5′
1.00′	Black slate	273.5′ to 274.5′
1.67′	Underclay	274.5′ to 276.17′

Bore No. 13.—West Kentucky Coal Co. Elevation of surface 370 feet. Locality 61.

30.8′	Surface material	0′ to 30.8′
0.5′	Coal	30.8′ to 31.3′
55′	Shale	31.3′ to 86.3′

4′	Fire clay	86.3′ to 90.3′
40′	Slaty soapstone	90.3′ to 130.3′
1′	Coal	130.3′ to 131.3′
87′	Shale	131.3′ to 218.3′
0.42′	Bone coal	218.3′ to 218.72′
2.0′	Underclay	218.72′ to 220.72′
6.0′	Light shale	220.72′ to 226.72′
24′	Dark shale	226.72′ to 250.72′
5.7′	Limestone	250.72′ to 256.42′
1′	Fire clay	256.42′ to 257.42′
2′	Sandstone	257.42′ to 259.42′
4′	Light shale	259.42′ to 263.42′
15′	Dark shale	263.42′ to 278.42′
1.5′	Limestone	278.42′ to 279.92′
6′	Red shale	279.92′ to 285.92′
1.8′	Light shale	285.92′ to 287.72′
3.2′	Limestone	278.72′ to 290.92′
1.2′	Limestone and shale mixed	290.92′ to 292.12′
3.88′	Limestone	292.12′ to 296′
29′	Sandstone	296′ to 325′
45.3′	Light shale	325′ to 370.3′
45.8′	Dark shale	370.3′ to 416.1′
1′	Coal	416.1′ to 417.1′
3′	Clay and shale	417.1′ to 420.1′
14.3′	Sandy shale	420.1′ to 434.4′
14.9′	Black slate	434.4′ to 449.3′
5.5′	Coal, Baker, No. 14	449.3′ to 454.8′
2.9′	Underclay	454.8′ to 457.7′

Bore No. 14.—West Kentucky Coal Co. Elevation of surface 360 feet. Locality 62.

28′	Sandy clay	0′ to 28′
29′	Sandy shale	28′ to 57′
57′	Blue shale	57′ to 114′
1.25′	Black shale	114′ to 115.25′
0.25′	Coal	115.25′ to 115.50′
2.50′	Underclay	115.50′ to 118′
14′	Sandstone	118′ to 132′
23′	Sandy shale	132 to 155′
16′	Sandstone	155′ to 171′
10′	Sandy shale	171′ to 181′
2.5′	Blue shale	181′ to 183.5′
1.5′	Limestone	183.5′ to 185′
17′	Red and blue shale	185′ to 202′
3′	Limestone	202′ to 205′
5′	Sandy shale	205′ to 210′

20′	Sandstone	210′ to 230′
14′	Sandy shale	230′ to 244′
109′	Blue shale	244′ to 353′
3′	Black shale	353′ to 356′
1.67′	Coal	356′ to 357.67′
0.75′	Black shale	357.67′ to 358.43′
2.50′	Soft blue shale	358.43′ to 360.93′
0.75′	Coal	360.93′ to 361.68′
1.67′	Blue shale	361.68′ to 363.35′
1.67′	Coal, top bench of Baker coal	363.35′ to 365.02′
0.08′	Blue band (shale)	365.02′ to 365.1′
5.92′	Coal, main bench of Baker coal	365.1′ to 371.02′
1 08′	Black shale	371.02′ to 372.1′

Bore No. 15.—West Kentucky Coal Co. Elevation of surface 360.5′. Locality 63.

55′	Surface	0′ to 55′
54′	Shale	55′ to 109′
53′	Sandy shale	109′ to 162′
6.78′	Dark shale	162′ to 168.78′
.11′	Coal	168.78′ to 168.89′
3.94′	Fire clay	168.89′ to 172.83′
5′	Shale	172.83′ to 177.83′
6.17′	Dark shale	177.83′ to 184′
18′	Sandstone	184′ to 202′
7.50′	Dark shale	202′ to 209.50′
5.50′	Limestone, Madisonville	209.50′ to 215′
2′	Fire clay	215′ to 217′
3.50′	Light shale	217′ to 220.50′
5′	Sandstone	220.50′ to 225.50′
13′	Light shale	225.50′ to 238.50′
4′	Black shale	238.50′ to 242.50′
1′	Limestone	242.50′ to 243.50′
3′	Fire clay	243.50′ to 246.50′
1.50′	Dark shale	246.50′ to 248′
4.50′	Limestone	248′ to 252.50′
27.50′	Sandstone	252.50′ to 280′
103′	Blue shale	280′ to 383′
.75′	Coal	383′ to 383.75′
2′	Fire clay	383.75′ to 385.75′
12′	Dark shale	385.75′ to 397.75′
9′	Sandstone	397.75′ to 406.75′
8.25′	Dark shale	406.75′ to 415′
7.50′	Coal, No. 14	415′ to 422.50′
1′	Fire clay	422.50′ to 423.50′

Log of Bore Hole No. 19.—West Kentucky Coal Co. Elevation 376'. Locality 114.

27'	Surface	0'	to 28'
24'	Shale	27'	to 51'
6'	Black shale	51'	to 57'
5'	Fire clay	57'	to 62'
108'	Shale	62'	to 170'
0.5'	Coal	170'	to 170.50'
5.5'	Fire clay	170.5'	to 176'
34'	Dark shale	176'	to 210'
7'	Limestone, Madisonville	210'	to 217'
6'	Sandstone	217'	to 223'
12'	Dark shale	223'	to 235'
1.33'	Limestone	235'	to 236.33'
2'	Fire clay	236.33'	to 238.33'
13.67'	Red shale	238.33'	to 252'
3'	Limestone	252'	to 255'
26'	Sandstone	255'	to 281'
111'	Shale	281'	to 392'
1.17'	Coal	392'	to 393.17'
1.83'	Fire clay	393.17'	to 395'
9'	Dark shale	395'	to 404'
.33'	Coal	404'	to 404.33'
9.67'	Shale	404.33'	to 414'
1.5'	Bony coal	414'	to 415.5'
12'	Sandstone	415.5'	to 427.5'
3'	Shale	427.5'	to 430.5'
1.5'	Coal, Baker	430.5'	to 432'
4'	Fire clay	432'	to 436'
1.5'	Sandstone	436'	to 437.5'
10'	Fire clay and lime boulders	437.5'	to 447.5'
1.5'	Limestone	447.5'	to 449'
2'	Varigated shale	449'	to 451'
2.33'	Limestone	451'	to 453.33'
5.67'	Varigated shale	453.33'	to 459'
6'	Soapstone	459'	to 465'
3.5'	Limestone	465'	to 468.5'
3'	Shale	468.5'	to 471.5'
7.5'	Soapstone	471.5'	to 479'
36'	Light shale	479'	to 515'
8'	Sandstone	515'	to 523'
7'	Dark shale	523'	to 530'
6.25'	Black shale	530'	to 536.25'
4.25'	Coal, No. 9	536.25'	to 540.50'
2'	Fire clay	540.50'	to 542.50'

Bore No. 20.—West Kentucky Coal Co. Elevation of surface, 380 feet. Locality 64.

30′	Surface material	0′	to 30′
20′	Sandstone	30′	to 50′
33′	Shale	50′	to 83′
4′	Black slate	83′	to 87′
0.42′	Coal	87′	to 87.42′
9′	Underclay	87.42′	to 96.42′
56′	Shale	96.42′	to 152.42′
0.33′	Coal	152.42′	to 152.75′
4.25′	Underclay	152.75′	to 157′
35′	Shale	157′	to 192′
8.5′	Limestone	192′	to 200.5′
10.5′	Shale	200.5′	to 211′
0.25′	Coal	211′	to 211.25′
6.00′	Underclay	211.25′	to 217.25′
20′	Shale	217.25′	to 237.25′
0.92′	Coal	237.25′	to 238.17′
185′	Shale	238.17′	to 423.17′
0.33′	Coal	423.17′	to 423.50′
1.50′	Underclay	423.5′	to 425′
16′	Shale	425′	to 441′
18′	Sandstone	441′	to 459′
7′	Shale	459′	to 466′
6′	Limestone, Madisonville	466′	to 472′
18′	Soapstone	472′	to 490′
1′	Limestone	490′	to 491′
10′	Red shale	491′	to 501′
4.5′	Limestone	501′	to 505.5′
8′	Shale	505.5′	to 513.5′
12.5′	Sandstone	513.5′	to 526′
21′	Shale and soapstone	526′	to 547′
82′	Dark shale	547′	to 629′
0.75′	Coal	629′	to 629.75′
6′	Underclay	629.75′	to 635.75′
20.25′	Shale	635.75′	to 656′
1′	Sandstone	656′	to 657′
6′	Dark shale	657′	to 663′
7.25′	Coal, Baker, with very thin dark, micaceous shale band in middle	663′	to 670.25′
1.75′	Underclay	670.25′	to 672′

Bore No. 21.—West Kentucky Coal Co. Elevation of surface 368 feet. Locality 65.

46′	Surface soil	0′	to 46′
31′	Shale	46′	to 77′

3′	Black shale	77′	to 80′
0.25′	Coal	80′	to 80.25′
8.75′	Underclay	80.25′	to 89′
57′	Shale	89′	to 146′
0.25′	Bony coal	146′	to 146.25′
5′	Underclay	146.25′	to 151.25′
31′	Shale	151.25′	to 182.25′
8.50′	Limestone	182.25′	to 190.75′
10.25′	Shale	190.75′	to 201′
0.33′	Coal	201′	to 201.33′
5.67′	Underclay	201.33′	to 207′
25′	Shale	207′	to 232′
1′	Coal	232′	to 233′
67′	Shale	233′	to 300′
8′	Black slate	300′	to 308′
108′	Shale	308′	to 416′
0.50′	Coal	416′	to 416.5′
1.5′	Underclay	416.5′	to 418′
12′	Sandstone	418′	to 430′
20′	Shale	430′	to 450′
7.5′	Sandstone	450′	to 457.5′
2.5′	Shale	457.5′	to 460′
5.5′	Limestone, Madisonville	460′	to 465.5′
19.5′	Shale	465.5′	to 485′
1.5′	Limestone	485′	to 486.5′
8.5′	Red shale	486.5′	to 495′
4.5′	Limestone	495′	to 499.5′
9.5′	Shale	499.5′	to 509′
12′	Sandstone	509′	to 521′
102.50′	Shale	521′	to 623.5′
0.92′	Coal	623.5′	to 624.42′
1.58′	Underclay	624.42′	to 626′
31′	Shale and sandstone	626′	to 657′
6′	Coal, Baker	657′	to 663′
1′	Underclay	663′	to 664′

Bore at Montezuma, three miles south of Clay. Elevation about 405 feet; depth to coal No. 6, 185 feet. Located "very near the corner" of the public road from Clay to Providence. Locality 9.

Log of Providence oil well, county fair grounds; elevation of surface approximately 375 feet. Mouth of well approximately 25 feet below horizon of coal No. 9. Record poor, identifications of material faulty, too much limestone shown, correlations very doubtful. Locality 16.

30′	Surface clay	0′	to 30′
10′	Limestone (?)	30′	to 40′

5′	Sandstone	40′	to 45′
20′	Black rock	45′	to 65′
10′	Limestone (?)	65′	to 75′
5′	Soapstone	75′	to 80′
35′	White sandstone	80′	to 115′
40′	Soapstone shale	115′	to 155′
10′	White sandstone	155′	to 165′
40′	Black soapstone and shale	165′	to 205′
5′	White sandstone	205′	to 210′
17′	Black soapstone or shale	210′	to 227′
1′ 7″	Coal	227′	to 228′ 7″
3′	White sandstone	228′ 7″	to 231′ 7″
20′	Soapstone	231′ 7″	to 251′ 7″
3′	White sandstone	251′ 7″	to 254′ 7″
15′	Black shale	254′ 7″	to 269′ 7″
36′	White sandstone	269′ 7″	to 305′ 7″
5′	Soapstone and fire clay	305′ 7″	to 310′ 7″
20′	White sandstone	310′ 7″	to 330′ 7″
3′	Soapstone	330′ 7″	to 333′ 7″
27′	Limestone	333′ 7″	to 360′ 7″
2′ 4″	Coal	360′ 7″	to 362′ 11″
1′	Underclay	362′ 11″	to 363′ 11′
4′	Soapstone	363′ 11″	to 367′ 11″
10′	Soapstone	367′ 11″	to 377′ 11″
10′	Limestone (?)	377′ 11″	to 387′ 11″
8′	Limestone and sand rock	387′ 11″	to 395′ 11″
5′ 1″	Soapstone	395′ 11″	to 401′
6′	Limestone (?)	401′	to 407′
13′	Oil rock, salt and pepper in color, full of pebbles	407′	to 420′
21′	Shale	420′	to 441′
18′	Sandstone	441′	to 459′
43′	Shale	459′	to 502′
16′	Bastard limestone	502′	to 518′
51′	Shale and soapstone	518′	to 569′

Oil sand showing slight amount of oil and strong salt water below 569′.

Log of shaft of Mine No. 3, Providence Mining Co. Elevation of surface 426.25 feet. Locality 39.

12′	Surface soil	0′	to 12′
3′	Coal No. 12	12′	to 15′
2′	Under clay	15′	to 17′
5′	Clay and gravel	17′	to 22′
5′ 6″	Soapstone	22′	to 27′ 6″

2′	6″	Sandstone	27′	6″	to 30′	
13′		Black jack	30′		to 43′	
6′		Coal, No. 11	43′		to 49′	
8′		Sandstone	49′		to 57′	
8′	6″	Soapstone	57′		to 65′	6″
3′	6″	Gray slate	65′	6″	to 69′	
4′	6″	Flinty sandstone	69′		to 73′	6″
0′	6″	Gob	73′	6″	to 74′	
4′	9″	Coal, pockety. No. 10	74′		to 78′	9″
2′		Underclay	78′	9″	to 80′	9″
3′		Soapstone	80′	9″	to 83′	9″
16′	3″	Very hard blue flinty sandstone	83′	9″	to 100′	
3′		Draw slate	100′		to 103′	
4′	10″	Coal, No. 9	103′		to 107′	10″

Log of shaft of Webster County Coal Co., Providence. Elevation of surface approximately 472 feet. Locality 56.

10′	Surface clay	0′	to	10′
55′	Blue shale	10′	to	65′
6′	Coal, No. 12	65′	to	71′
12′	Shale	71′	to	83′
8′	Limestone	83′	to	91′
6′	Coal, No. 11	91′	to	97′

Bore of Webster County Coal Co., one mile north north-east of their shaft in Providence. Elevation at surface approximately 416 feet. No log given but depth to No. 11 coal is 138 feet. Locality 82.

Log of Shamrock shaft, St. Bernard Mining Co., one mile east of Providence. Elevation of surface 400 feet. Locality 55.

43′		No record	0′		to 43′	
5′		Coal, No 12, poor	43′		to 48′	
15′	4″	Shale	48′		to 63′	4″
6′	2″	Limestone	63′	4″	to 69′	6″
	6″	Gob	69′	6″	to 70′	
6′		Coal, No. 11	70′		to 76′	

Log of Justice No. 1 bore, two miles east of Providence. Elevation of surface 390 feet. Drilled in 1902 by John Givens. Locality 83.

4′	Surface soil	0′	to	4′
16′	Sandstone and soapstone	4′	to	20′
9′	Soapstone	20′	to	29′
2′	Limestone	29′	to	31′
108′	Soapstone, partly sandy, partly calcareous	31′	to	139′

0′ 6″	Black slate	139′	to 139′ 6″
4′	Limestone	139′ 6″	to 143′ 6″
14′	Soft limestone	143′ 6″	to 157′ 6″
1′ 6″	Soapstone	157′ 6″	to 159′
7′	Coal, No. 12	159′	to 166′
1′	Underclay	166′	to 167′
18′	Limestone	167′	to 185′
7′	Coal, No. 11	185′	to 192′
3′	Underclay	192′	to 195′
15′	Limestone (?)	195′	to 210′
42′	Sandstone	210′	to 252′
25′	Gray slate	252′	to 277′
3′	Black slate	277′	to 280′
5′ 6″	Coal, number 9	280′	to 285′ 6″

Log of Lisman well. Elevation of surface approximately 385 feet. Locality 84.

22′	Surface clay	0′	to 22′
23′	Soapstone	22′	to 45′
10′	Bastard limestone	45′	to 55′
1′	Coal	55′	to 56′
24′	Sandstone grading down to soapstone and slate	56′	to 58′
10′	Bastard limestone	80′	to 90′
33′	Soapstone, partly sandy	90′	to 123′
27′	Soapstone	123′	to 150′
10′	Black slate	150′	to 160′
10′	Gobby, mucky, soapstone changing to sandstone	160′	to 170′
10′	Sandstone	170′	to 180′
10′	Bastard limestone, hard	180′	to 190′
5′	Limestone	190′	to 195′
3′	Soapstone	195′	to 198′
30′	Limestone (probably partly calcareous shale)	198′	to 228′
7′	Shale	228′	to 235′
10′	Sandstone	235′	to 245′
39′	Soapstone	245′	to 284′
4′	Black slate	284′	to 288′
14′	Fire clay and slate	288′	to 302′
13′	Sandy soapstone	302′	to 315′
5′	Gray sandstone	315′	to 320′
2′	Black slate	320′	to 322′
1′ 6″	Coal	322′	to 323′ 6″
1′ 6″	Underclay	323′ 6″	to 325′
8′	Limestone	325′	to 333′

12′	Gray sandstone	333′	to 345′
18′	Limestone	345′	to 363′
23′	Slate of soapstone	363′	to 386′
10′	Sandstone	386′	to 396′
4′	Soapstone or gray slate	396′	to 400′

Another log of this Lisman bore, differing from the above in minor particulars, is given on page 141 of Bull. 1, Ky. Geol. Survey.

Dixon well, on hill one mile southeast of Dixon court house. Elevation of surface approximately 530 feet, no log obtainable. Depth reported by Mr. Marion Baker as 440 feet. No coals of importance were struck. Locality 85.

Log of upper part of 1600-foot well three-fifths of a mile north of Tilden or Jones Stand, on west side of creek. Data from A. B. Sights. Elevation of surface approximately 405 feet. Locality 86.

28′	Surface material	0′	to	28′
30′	Limestone (sandstone?)	28′	to	58′
87′	Slate	58′	to	145′
16′	Light sandstone	145′	to	161′
6′	Coal, Baker (?)	161′	to	167′
5′	Underclay	167′	to	172′
13′	Limestone (sandstone?)	172′	to	185′
9′	Slate	185′	to	194′
13′	Sandstone, with oil	194′	to	207′
5′	Slate and sand	207′	to	212′
1′	Coal, No. 11(?)	212′	to	213′
46′	White sand	213′	to	259′
47′	Slate and sand	259′	to	306′
5′	Black slate	306′	to	311′
4′	Coal, No. 9(?)	311′	to	315′
10′	Limestone and sand	315′	to	325′
10′	Sandstone	325′	to	335′
29′	Slate	335′	to	364′
2′	Coal	364′	to	366′
5′	Limestone	366′	to	371′
40′	Sandstone, fine	371′	to	411′
5′	Sandstone and slate	411′	to	416′
65′	Gray slate	416′	to	481′
10′	Black slate	481′	to	491′
10′	Sandstone and lime	491′	to	501′
40′	Slate	501′	to	541′
10′	Sandstone and lime	541′	to	551′
25′	Sandstone	551′	to	576′
7′	Slate	576′	to	583′
10′	Sandstone and slate	583′	to	593′

18′	Slate	593′	to	611′
15′	White sandstone	611′	to	626′
5′	Dark sandstone	626′	to	631′
35′	Slate	631′	to	666′
15′	Black slate	666′	to	681′
10′	Slate, sandy	681′	to	691′
60′	Sandstone, with salt water	691′	to	751′
5′	Dark sandstone	751′	to	756′
10′	Slate	756′	to	766′
10′	Limestone (sandstone?)	766′	to	776′
48′	Black slate grading down into gray	776′	to	824′
5′	Coal	824′	to	829′
10′	Brown sandstone changing to gray	829′	to	839′
25′	White sandstone	839′	to	864′
7′	Slate	864′	to	871′
21′	Gray sand	871′	to	892′
7′	Slate	892′	to	899′
12′	Slate and lime	899′	to	911′
31′	Slate	911′	to	942′
16′	Sandstone, light colored	942′	to	958′
45′	Slate	958′	to	1003′
30′	Gray sandstone	1003′	to	1033′

Continuation of record to 1600 feet torn from book.

Complete copy once furnished the Kentucky Geological Survey but not now obtainable. A somewhat different log of above well published in Ser. 5, Bull. 1, Oil and Gas Rsources of Ky., by Dr. Jillson, pp. 520-521. Record there to 1429′.

Log of well on W. A. Duncan farm 300 yards east of Jones Stand. Drilled in 1910-1911 by Dearolph and Sarber. Elevation of surface approximately 430 feet. Locality 87.

11′	Surface clay	0′	to	11′
39′	Hard pan with water	11′	to	50′
115′	Slate	50′	to	165′
2′	Coal	165′	to	167′
18′	Slate	167′	to	185′
2′	Coal	185′	to	187′
113′	Slate	187′	to	300′
40′	Sandstone	300′	to	340′
5′	Slate	340′	to	345′
7′	Coal	345′	to	352′
88′	Shale	352′	to	440′
20′	Sandstone, sharp	440′	to	460′
157′	Shale	460′	to	617′
5′	Coal	617′	to	622′

73′	Shale	622′	to 695′
55′	Sandstone and fresh water	695′	to 750′
90′	Shale	750′	to 840′
4′	Coal	840	to 844′
96′	Shale	844′	to 940′
18′	Sandstone, sharp, with light oil at 945	940′	to 958′
137′	Lime, shells and shale	958′	to 1095′
227′	Sandstone, very sharp	1095	to 1322′
50′	Lime and slate	1322′	to 1372′
38′	Sandstone, salt water abundant	1372′	to 1410′
90′	Slate and shells	1410′	to 1500′
14′	Black slate	1500′	to 1514′
5′	Stray lime	1514′	to 1519′
401′	Slate and shells	1519′	to 1920′

Sandstone at 1920′ with abundant salt water. Fresh water at 1115′; salt water at 1195′; bad cave-in at 1480′.

Another record gave for a portion of the above well the following:

235′	Sandstone, Caseyville formation	1095′	to 1330′
40′	Slate	1330′	to 1370′
56′	Sandstone	1370′	to 1426′
54′	Slate	1426′	to 1480′
10′	Sandstone	1480′	to 1490′
24′	Slate	1490′	to 1514′
34′	Limestone	1514′	to 1548′
15′	Slate	1548′	to 1563′
7′	Gray limestone	1563′	to 1570′
	Then into slate		

Log of well at Sebree, 300 feet north of depot and a few feet east of railway track. Drilled in 1904. Elevation about 395 feet. Locality 68.

10′	Clay	0′	to 10′
40′	Sandstone, Anvil Rock	10′	to 50′
3′ 6″	Hard limestone	50′	to 53′ 6″
4′	Coal, No. 11	53′ 6″	to 57′ 6″
66′	Soapstone or clay	57′ 8″	to 123′ 6″
48′	Sandstone	123′ 6″	to 171′ 6″
3′	Black slate	171′ 6″	to 174′ 6″
4′ 9″	Coal, No. 9	174′ 6″	to 179′ 3″
3′ 9″	Underclay	179′ 3″	to 183′
35′	Sandy shale	183′	to 218′
40′	Sandstone	218′	to 258′

5′	Gray slate	258′	to 263′
4′	Coal	263′	to 267′
40′	Soapstone	267′	to 307′
34′	Sandstone	307′	to 341′
70′	Sandy shale	341′	to 411′
15′	Soapstone	411′	to 426′
34′	Sandstone	426′	to 460′
5′	Sandy shale	460′	to 465′
30′	Slate and shale	465′	to 495′
27′	Soapstone	495′	to 522′
8′	Hard sandstone	522′	to 530′
65′	Sandstone with soft streaks, oil	530′	to 595′

Struck oil at 532′; salt water at 555′; gas at 560′-565′.

Log of shaft of Sebree Coal and Mining Co. Elevation at surface 409 feet. Locality 44.

10′	Surface clay	0′	to 10′
22′ 6″	Sandstone, Anvil Rock	10′	to 32′ 6″
5′ 6″	Gray slate	32′ 6″	to 38′
4′	Fire clay	38′	to 42′
10′	Sandstone	42′	to 52′
2′ 6″	Limestone	52′	to 54′ 6″
4′ 9″	Coal, No. 11	54′ 6″	to 59′ 3″
2′ 9″	Underclay	59′ 3″	to 62′
.....	Sandstone, very thin	.....	.....
16′	Soapstone	62′	to 78′
18′ 6″	Sandy shale	78′	to 96′ 6″
11′ 3″	Fire clay	96′ 6″	to 107′ 9″
58′ 3″	Sandstone	107′ 9″	to 166′
2′	Black slate	166′	to 168′
4′ 10″	Coal, No. 9	168′	to 172′ 10″
3′	Under clay	172′ 10″	to 175′ 10″

Well at Sebree. Copied from pages 140-141 of Bulletin 1, Kentucky Geological Survey. Location not given, probably the L. & N. R. R., bore hole near the preceding bore but on the west side of the track and at practically the same elevation. Locality 69.

52′	Clay and sand	0′	to 52′
6′	Soft sandstone	52′	to 58′
66′	Soapstone and clay	58′	to 124′
8′	Sand rock	124′	to 132′
50′	Soft sandstone	132′	to 182′
33′	Slate	182′	to 215′
1′ 6″	Coal	215′	to 216′ 6″

5′	Underclay	216′	6″ to 221′	6″
8′	Limestone	221′	6″ to 229′	6″
27′	Sandy shale	229′	6″ to 256′	6″
6′	Slate	256′	6″ to 262′	6″
3′ 6″	Coal	262′	6″ to 266′	
40′	Soapstone and shale	266′	to 306′	
29′	Sand rock	306′	to 335′	
75′	Sandy shale	335′	to 410′	
15′	Soapstone	410′	to 425′	
15′	Sandstone	425′	to 440′	
20′	Soapstone	440′	to 460′	
5′	Sandy shale	460′	to 465′	
28′	Black shale	465′	to 493′	
2′	Hard lime	493′	to 495′	
3′	Coal	495′	to 498′	
24′	Soapstone	498′	to 522′	
6′	Sandstone	522′	to 528′	
2′	Soapstone	528′	to 530′	
62′	Sandstone with soft strata	530′	to 592′	
3′	Soapstone	592′	to 595′	

In the 62′ of sandstone at 530 to 592′, oil, salt water and gas were reported.

Log of Jim Trice well, drilled one and one-half miles northeast of Dixon, Ky. Drilled by Morarity for Noon Oil and Gas Company. Spudded in December 13, 1918. Production, dry. Locality 90. Elevation about 560 feet.

Strata	Thickness	Depth
Soil (conductor 16 in. case)	20	0— 20
Shale	80	20— 100
Slate	100	100— 200
Lime	50	200— 250
Sand (water at 270′)	30	250— 280
Shale	70	280— 350
Lime	50	350— 400
Sand	50	400— 450
Slate	150	450— 600
Sand	50	600— 650
Slate	100	650— 750
Lime	50	750— 800
Slate (blue)	100	800— 900
Sand	25	900— 925
Shale (white)	75	925—1000
Lime (very hard)	50	1000—1050
Slate	50	1050—1100

Strata	Thickness	Depth
Lime	25	1100—1125
Slate	35	1125—1160
Lime (very hard)	10	1160—1170
Sand	70	1170—1240
Slate	60	1240—1300
Sand	60	1300—1360
Slate	40	1360—1400
Lime	50	1400—1450
Slate	150	1450—1600
Lime	10	1600—1610
Sand	40	1610—1650
Slate	80	1650—1730
Sand (water, 760′)	45	1730—1775
Shale	25	1775—1800
Lime	150	1800—1950
Slate	50	1950—2000
Sand	200	2000—2200
Slate	50	2200—2250
Sand	50	2250—2300
Slate	100	2300—2400
Sand	100	2400—2500
Slate	25	2500—2525
Lime	25	2525—2550
Unrecorded sediments	190	2550—2740
Total depth		2740

This entire Trice log is problematical as to its accuracy. The indentification of hard beds is poor. Very little of what is given as limestone in the upper 2,000 feet can really be limestone. Most of it is certainly sandstone. The hole must have gone through the entire series of coals but no coal whatever is noted in the log. Some of the shales were black while others were red or green and yet no note of either color is made. The Dixon sandstone occurs from 200 to 280 feet down—counting the 50 feet of limestone (200-250) as really sandstone—and is thicker than found in any surface exposure. Below there no divisions are determinable. The limestone given from 1,800 to 1,950 feet is almost certainly sandstone. It may be the upper part of the Caseyville, or possibly the entire Caseyville. If so the limestone at 1,400 to 1,450 would probably be really sandstone and correlate with the Sebree sandstone and much or all of the sandstone given below 2,000 feet would really be limestone and belong to the Mississippian. Again, the Caseyville

formation might include the rocks from 1,800 to 2,200, or from 2,000 to 2,200 or 2,000 to 2,500. It seems certain that the lower 240 feet, if not more, is Mississippian. Those interested in attempting to solve a hopeless correlation puzzle may plot the sections of the Jim Trice, the W. A. Duncan, the Sights, and the Lisman bore holes and compare them. The writer's conclusion from such effort is that the Trice record is practically worthless.

This Trice well was drilled in the main syncline of the region in a most admirable place for giving a fine and greatly desired geological section but in an unfavorable place for oil if the deep-lying porous beds carry salt water, as they most probably do through this entire syncline.

Sebree Springs Well. A well was drilled for oil on the flat a few rods west of the railroad track and 300 to 400 yards south of Sebree Springs about 1913 or 1914. Locality 91. The elevation of the top is about 400 feet. The well started some 35 feet below the top of the massive conglomerate that here forms the top of the Caseyville Formation. Drillings were sent to the Kentucky Geological Survey office while drilling was going on. From them record No. 1 below was made. Later they sent other samples from which record No. 2 was made. These do not agree very well with each other. They make it probable that the base of the Pennsylvanian was reached at a depth of 530 or 550 feet. If so the Caseyville Formation was either about 565 or 585 feet thick or the well passed through a fault plane on which the trust from the south had duplicated part of the Caseyville. The nearest visible faulting is about a half mile to the north. The two records are as follows:

No. 1.

Dark carbonaceous shale	75	to	83
Dark shale	83	to	315
Light gray sand	315	to	550
Gray fossiliferous limestone	550	to	695
Gray limestone	695	to	710
Gap to			960
Gray limestone	960	to	1016

No. 2.

Soil	30 feet.
At	50 feet sandstone.
At	75 feet sandstone.

At 130 feet sandstone.
At 155 feet white sandstone.
At 232 feet sandstone mixed with coal.
At 370 feet gray shale.
At 420 feet dark shale.
At 500 feet sandstone.
At 530 feet limestone.
At 595 feet sandstone.
At 625 feet blue shale.
At 644 feet hard limestone.
At 670 feet blue shale.
At 695 feet sandstone.
At 816 feet gray shale.
At 858 feet sandstone (salt sand).
At 888 feet blue shale.
At 910 feet blue shale.
At 965 feet red shale.
At 985 feet black slate.
At 1010 feet limestone.

In this set of drillings nothing was given in the intervals between the depths given. There may be added a third partial record of the same well as follows:

No. 3.—Copied from "Oil and Gas Resources of Kentucky" by W. R. Jillson, Kentucky Geological Survey, Ser. V, Bull. 1, p. 520, 1920. As this record is practically the same as No. 1 above down to 1016 feet, only the part below that depth is given here.

Gray limestone	1060 to 1070
Sand	1110 to 1210
Dark limestone—oil show	at 1715
Dove-colored limestone	at 1934
Gray limestone	1934 to 1940
Shaly limestone	1940 to 1946
Dark limestone	1946 to 2081
Dark shale	2081 to 2093
Gray limestone	2093 to 2107
Very dark limestone	2107 to 2226
Dark sandy limestone	2226 to 2232
Gray limestone	2232 to 2260
Dark limestone	2260 to 2275
White limestone	3058 to 3064

From local sources it has been learned that the total depth of this well was 3,200 feet. The first oil was found at 2,100 feet where eleven feet of sand gave a good showing. At 3,185 feet

there was another nice showing of oil and it was regarded as going to make a good well until it was shot. After the shot no more oil could be gotten. At some point gas enough to blaze eight or ten feet high was struck and six years later the open hole was full of salt water through which some gas still bubbled. The strongest salt water was found at 270 and 1,100. A short surface string of casing was set, a second one was set at 270 feet and a third at 1,100 feet, below which there was no more water than was needed to drill.

CHAPTER IX.

ANALYSES OF COAL

In the following pages there are given analyses of some 73 samples of coal. Most of these were standard mine samples cut from a fresh face of coal and shipped in a sealed container. A few are car or other individual samples and a few are composite. In each case the kind of sample is indicated. Somewhat more than half of the samples were analyzed in the laboratory of the Kentucky Geological Survey. The rest were analyzed by the U. S. Bureau of Mines either by cooperative agreement with the Kentucky Survey or on the Bureau's own account. Most of these analyses have been published either by the Bureau of Mines or

NO. 29. TIPPLE AT WHEATCROFT.

The West Kentucky Coal Co. loads coal from mines 3, 4 and 6 at this tipple.

the Kentucky Geological Survey or both. They are gathered together here for convenience in studying Webster county coals. The analyses made by the U. S. Bureau of Mines are so designated. All others were made by the Kentucky Geological Survey.

Four types of analyses are included in the list. In one type the coal is analyzed as received with whatever moisture it may have accidentally had in it when the sample was taken. Since the same coal may be sampled, even sometimes in the same room, either very wet or very dry, this first type of analysis is not a fair index of the quality of the coal. Even when sampled without visible dampness the fresh coal has always a certain amount or normal mine moisture that largely dries out when exposed to the air as in shipping and storing. This moisture is present when the car weight is taken on shipping from the mine. It is mostly absent after stocking for a short time. The second type of analysis is that of the coal when air-dried. This type represents more nearly the coal as actually used than any other and is the one most valuable for determining the commercial quality of the coal and enabling comparisons to be made with other coals. All statements of quality and comparisons in this report are based on the air-dried sample.

The third type of analysis represents the coal as it would be if all moisture were removed, while the fourth type represents the coal as it would be if both all moisture and all ash were removed. These last two are obtained by recalculation. They do not represent the coal as actually bought and used and do not show the relative practical value of the coals. They are of use to the mechanical engineer and to the coal chemist and student rather than to the ordinary coal user.

Coals are mechanical mixtures of a number of substances whose proportions often vary rapidly and, it may also be, notably in the same seam within even a few feet at times. These variations show in the analyses even when the samples were all taken from the same mine and the analytical work done by the same set of men. They are due not to carelessness on the part of the samplers and analysts but to variations in the coal. This is illustrated by comparing the analyses of the six Bureau of Mines samples of number 9 coal from the Providence Coal Company's mine No. 3, or the 9 Bureau of Mines samples of No. 11 coal from the Shamrock mine near Providence, or of the 10 Bureau of Mines samples of No. 14 coal from Mine No. 7 of the West Kentucky Coal Co. near Clay.

NO. 30. CROSS-OVER DUMP.

This shows interior arrangement in the tipple shown in preceding view for handling the large tonnage that daily passes through it.

While this is true yet when a group of analyses of the same coal are compared, certain average characteristics become apparent and from these averages we may with considerable confidence speak of the general character of the coal. Such averages have been made for each of the seams here analyzed and are given in the following table.

Averages of Analyses of Each Coal.
Air Dried Basis.

Coal	No. of Analyses	Loss Air-drying	Moisture	Volatile	Fixed Carbon	Ash	S.	B. T. U.	Ratio Fuel
No. 6	2	5.35	3.40	38.04	50.36	8.19	3.46	13,676	1.32
No. 9	31	3.25	3.68	37.58	49.47	9.25	3.56	12,752	1.31
No. 11	24	2.70	2.86	38.88	49.14	8.65	3.74	12,860	1.26
No. 12	1	1.60	1.96	41.40	47.55	9.09	4.44	13,013	1.15
No. 14	15	2.22	3.27	35.90	52.10	8.72	1.54	13,087	1.45
Av. of all	73	2.88	3.33	37.73	49.90	8.91	3.22	12,898	1.32

In the above table of averages it should be noted that the number of analyses used for determining loss on air drying and B. T. U. for coals 9 and 11 was slightly less than the numbers as given. It is unfortunate that only two analyses are available for coal 6 and only one for coal 12. The number of analyses of coals 9, 11 and 14 is so large that considerable confidence may be reposed in the averages for these coals.

As to moisture it will be noted that the largest total and largest air-drying loss is in coal 6 and the smallest in coal 12. Coal 9 is intermediate in these respects and coals 11 and 14 show less than 9; coal 14 being slightly less than 11 in total moisture. The total moisture content for the entire group of 73 analyses is considerably lower than that for the coals of the main portion of the eastern interior field in Indiana and Illinois.

In volatile matter the single analysis of number 12 coal gives the highest volatile content found in any one of the 73 analyses, although it is from the Marks mine on the western end of the Sebree anticline where we would expect deformation to reduce the volatile matter below its normal amount in undeformed areas. Since no other analyses of number 12 are available for comparison it cannot be determined whether number 12 normally carries unusually high volatile matter or not. Coals 6, 9 and 11 do not differ materially in average volatile matter, 11 being slightly higher. Coal 14, or the Baker coal, however, is notably lower in volatile matter than any other coal in the county for which analytical data are available.

In properly constructed and operated steam plants where the volatile matter is entirely consumed it is a somewhat more valuable constituent of coal than the same weight of fixed carbon, but in improperly operated steam plants and in the usual household grate or furnace it is less valuable because much of it escapes unburned in the form of a dense black smoke.

In fixed carbon number 12 averages lowest, numbers 6, 9 and 11 are intermediate and number 14 is notably highest.

In ash they are all fairly alike with 8 or 9 per cent each when averaged but with individual analyses running below 5 per cent or above 11 per cent. Number 9 averages slightly higher in ash than either of the others.

In sulphur, the single analysis of number 12 coal is highest with nearly 4.5 per cent. Numbers 6, 9 and 11 are nearly similar to each other with about 3.5 per cent, while number 14 is notably lower with only about 1.5 per cent.

In British thermal units coal number 6 stands highest, so far as the two analyses go. Coals 12 and 14 rank next and coals 9 and 11 are lowest.

In fuel ratio—obtained by dividing the percentage of fixed carbon by the percentage of volatile matter—coal 12 is lowest, coals 6, 9 and 11 are close together and intermediate and coal 14 is highest.

Taken all in all coal 14, the Baker coal, ranks highest of the coals here analyzed.

Lee[18] attributes the lower moisture content and consequently higher volatile and fixed carbon content and higher fuel ratio of the coals south of the Rough creek fault, when compared to the coals north of this fault in Kentucky, Illinois, and Indiana, to the influence of the fault. The rocks south of the fault have suffered more deformation than those north of it. It is probable that this has contributed somewhat to the very striking differences between the Kentucky coals on the one hand and the average Illinois and Indiana coals on the other. Much of this difference is believed by the writer, however, to be due to the general regional difference between the coals on the southeastern edge of the eastern interior field and those in the center of it. There is a progressive change to the westward that results in lowering the average quality of the coals as one goes west or northwest.

ANALYSES of NO. 6 COAL; OWEN'S NO. 5 COAL.

Laboratory No. G-3474—Coal, labeled "Coal No. 6 from A. A. Teague's mine, 4 miles west of Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1¾ lbs. of small lumps and fine coal, received in a sealed glass jar. Analyzed January 10, 1912.

[18] Geol. of Shawneetown Quadrangle in Kentucky, Ky. Geol. Surv., pp. 59-60, 1916.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.14
Moisture lost on air-drying 1 hour at 105° C.	3.19	.....
Volatile combustible matter	38.36	37.59
Fixed carbon	49.59	48.59
Ash (brown)	8.86	8.68
Total	100.00	100.00
Sulfur	3.63	3 56
Coke	58.45	57.27
Specific gravity	1.330	
B. T. U. per pound	13,210.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3476.—Coal, labeled "Coal No. 6 from Vaughn and Nesbit's mine, 5 miles northwest of Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1¾ lbs. of small lumps and fine coal mixed. Received in a sealed glass jar. Analyzed January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.57
Moisture lost on air-drying 1 hour at 105° C.	3.61	.....
Volatile combustible matter	37.73	36.96
Fixed carbon	51.13	50.09
Ash (brown)	7.53	7.38
Total	100.00	100.00
Sulfur	3.30	3.23
Coke	58.66	57.47
Specific gravity	1.316	
B. T. U. per pound	14,142.	

(Analysis by J. S. McHargue.)

ANALYSES OF COAL NO. 9.

Laboratory No. 3559.—Coal, labeled "No. 9 coal from E. Curry's mine, 2 miles west of Wheatcroft, Webster County, Ky." Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.61
Moisture at 104°-107° C.	2.78
Volatile combustible matter	36.80

Fixed carbon	51.39
Ash (reddish)	9.03
Total	100.00
Sulphur	3 33
Coke (porous and friable)	60.42
Specific gravity	1.404

J. S. McHargue, Chemist.

Laboratory No. G-3478.—Coal, labeled "Coal No. 9 from McGraw mine, 2 miles west of Wheatcroft, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed. Received in a sealed glass jar. Analyzed January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	4.48
Moisture lost on air-drying 1 hour at 105° C.	2.41	.....
Volatile combustible matter	38.47	37.66
Fixed carbon	49.85	48.79
Ash (brown)	9.27	9.07
Total	100.00	100.00
Sulfur	4.15	4.06
Coke	59.12	57.86
Specific gravity	1.340	
B. T. U. per pound	13,207.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3477.—Coal, labeled "Coal No. 9 from Wallace mine, 2 miles west of Wheatcroft, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed. Received in a sealed glass jar. Analyzed January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	3.57
Moisture lost on air-drying 1 hour at 105° C.	3.06	.....
Volatile combustible matter	37.06	36.86
Fixed carbon	50.25	49.99
Ash (brown)	9.63	9.58
Total	100.00	100.00
Sulfur	4.34	4.32
Coke	59.88	59.57
Specific gravity	1.355	
B. T. U. per pound	13,113.	

(Analysis by J. S. McHargue.)

Laboratory No. 3556.—Coal, labeled "Coal No. 9 from Fairmont Coal Mining Co., Fairmont, Webster County, Ky." Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.82
Moisture at 104°-107° C.	2.30
Volatile combustible matter	37.42
Fixed carbon	50.83
Ash (brown)	9.45
Total	100.00
Sulphur	3.58
Coke (porous and friable)	60.28
Specific gravity	1.377

J. S. McHargue, Chemist.

Laboratory No. 3555.—Coal, labeled "Coal No. 9 from W. A. Galbreath's mine, 2 miles south of Clay, Webster County, Ky." Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	2.702
Moisture at 104°-107° C.	2.78
Volatile combustible matter	36.53
Fixed carbon	50.55
Ash (reddish)	10.14
Total	100.00
Sulphur	3.79
Coke (porous and friable)	60.69
Specific gravity	1.351

J. S. McHargue, Chemist.

Laboratory No. 3560.—Coal, labeled "Coal No. 9 from Thos. Blackwell Coal Mining Co., 1½ miles south of Clay, Webster County, Ky." Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.45
Moisture at 104°-107° C.	2.94
Volatile combustible matter	37.39
Fixed carbon	49.99
Ash (reddish)	9.68
Total	100.00
Sulphur	3.49
Coke (porous and friable)	59.67
Specific gravity	1.347

J. S. McHargue, Chemist.

Laboratory No. G-3093—Coal No. 9, labeled "Thos. Blackwell Coal and Mfg. Company, Clay, Webster County, Ky. Face of room No. 1 on first left entry. Thickness of seam 56"." Collected by Spillman. Average sample of medium sized lumps of coal having a rather dull luster and containing some scales of calcite. Not a very good looking coal. Analyzed July 6, 1909.

Analysis of the Air Dried Sample.	Per Cent
Moisture	2.60
Volatile combustible matter	35.15
Fixed carbon	52.15
Ash (lilac)	10.10
Total	100.00
Sulfur	4.13
Specific gravity	1.349
Coke	62.25
Phosphorus	trace

(Analysis by J. S. McHargue.)

Laboratory No. 3554.—Coal from mine of Diamond Coal Co., 4 miles northwest of Providence, Webster County, Ky., No. 9 coal. Collected by L. C. Glenn, 1911. In sealed glass jar. Analyzed May 20, 1912.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.35
Moisture at 104°-107° C.	3.15
Volatile combustible matter	38 85
Fixed carbon	48.67
Ash (reddish)	9.33
Total	100.00
Sulfur	3.16
Coke (porous and friable)	58.00
Specific gravity	1.305

(Analysis by J. S. McHargue.)

Laboratory No. G-3483.—Coal, labeled "Coal No. 9, Ruckman Coal Company, Providence, Webster County." Collected by L. C. Glenn, 1911. Sample consisted of about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analyzed January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.45
Moisture lost on air-drying 1 hour at 105° C.	4.00	.....
Volatile combustible matter	36.70	36.15

Fixed carbon	50.20	49.44
Ash (brown)	9.10	8.96
Total	100.00	100.00
Sulfur	1.96	1.93
Coke	59.30	58.40
Specific gravity	1.342	
B. T. U. per pound	13,175.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3482.—Coal, labeled "Coal No. 9, Leeper Coal Company, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. Sample, about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analysis made January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.70
Moisture lost on air-drying 1 hour at 105° C.	4.46	.....
Volatile combustile matter	35.74	35.27
Fixed carbon	54.34	53.63
Ash	5.46	5.40
Total	100.00	100.00
Sulfur	3.46	3.42
Coke	59.80	59.03
Specific gravity	1.361	
B. T. U. per pound	12,895.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3481.—Coal, labeled "Coal No. 9 from H. D. Hill, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analysis made January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.86
Moisture lost on air-drying 1 hour at 105° C.	4.46	.....
Volatile combustible matter	38.29	37.73
Fixed carbon	49.65	48.92
Ash (brown)	7.60	7.49
Total	100.00	100.00
Sulfur	2.93	2.89
Coke	57.25	56.41
Specific gravity	1.295	
B. T. U. per pound	12,861.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3480.—Coal, labeled "Coal No. 9 from S. K. Luton, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed, in a sealed glass jar. Analysis made January 10, 1912.

Analysis	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	6.01
Moisture lost on air-drying 1 hour at 105° C.	4.37	.....
Volatile combustible matter	38.02	37.37
Fixed carbon	50.18	49.32
Ash (brown)	7.43	7.30
Total	100.00	100.00
Sulfur	2.60	2.56
Coke	57.61	56.62
Specific gravity	1.274	
B. T. U. per pound	12,611.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3084.—Coal, No. 9, labeled "Coal from S. K. Luton's mine, Providence, Webster County, Ky., near face of first left entry. Thickness of seam 55 in." Average sample of medium sized lump coal, having a rather dull luster and containing some pyrites. Looks to be of medium quality only. Collected by Spillman. Analyzed June 29, 1909.

Analysis.	Per Cent.
Moisture	3.31
Volatile combustible matter	36.29
Fixed carbon	51.03
Ash (lilac)	9 37
Total	100.00
Sulfur	4.44
Specific gravity	1.350
Coke (porous)	60.40
Phosphorus	trace

(Analysis by J. S. McHargue.)

Laboratory No. G-3092.—Coal, No. 9, labeled "S. K. Luton's mine, Providence, Webster County, Ky., near face of main entry. Thickness of seam 58 inches." Average sample of medium sized lumps of coal having a rather dull luster and containing some pyrites. Collected by Spillman(?). Analyzed July 6, 1909.

Analysis of the Air Dried Sample.	Per Cent
Moisture	3.15
Volatile combustible matter	38.05
Fixed carbon	49.90
Ash (lilac)	8.90
Total	100.00
Sulfur	3.80
Specific gravity	1.331
Coke	58.80
Phosphorus	trace

(Analysis by J. S. McHargue.)

Laboratory No. G-3489.—Coal, No. 9, from Webster county. No label with sample. Jar marked "Monroe No. 9 coal. Collector's No. 17, Monroe mine, Providence, Ky." Collected by L. C. Glenn. Analysis made November 23, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture at 105° C.	3.33
Volatile combustible matter	36.85
Fixed carbon	51.42
Ash	8.40
Total	100.00
Sulfur	3.09
Coke	59.82
Specific gravity	1.308
B. T. U. per pound	12,982.
Moisture lost on air-drying	1.98

(Analysis by J. S. McHargue.)

Laboratory No. G-3488.—Coal from Webster County, labeled "Webster County, Ky., No. 9 coal. Tom Wanless, Providence, Ky. 4' 9"," Collected by L. C. Glenn. Analysis made November 23, 1911.

Analysis of the Air Dried Sample.	Per Cent.
Moisture at 105° C.	3.53
Volatile combustible matter	37.14
Fixed carbon	50.85
Ash	8.48
Total	100.00
Sulfur	3.07
Specific gravity	1.326
Coke	59.33
B. T. U. per pound	12,833.
Moisture lost on air-drying	1.24

(Analysis by J. S. McHargue.)

Laboratory No. G-3091.—Coal dust, No. 9 coal, labeled "Machine dust from electric machine in shaft mine of Providence Coal Company, Providence, Ky." Average sample consisting chiefly of coal dust and very small lumps of coal. Collected by Spillman. Analyzed July 6, 1909.

Analysis.	Per Cent.
Moisture	3.60
Volatile combustible matter	34.55
Fixed carbon	50.51
Ash (lilac)	11.34
Total	100.00
Sulfur	3.52
Specific gravity	1.343
Coke	61.85
Phosphorus	trace

(Analysis by J. S. McHargue.)

Laboratory No. G-3487.—Coal, labeled "Coal, No. 9 from No. 1 mine, Providence Mining Company, Providence, Webster County, Ky." Sample collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal, received in a sealed glass jar. Analysis made December 14, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.18
Moisture lost on air-drying 1 hour at 105° C.	3.12	.....
Volatile combustible matter	37.47	36.67
Fixed carbon	51.30	50.21
Ash (brown)	8.11	7.94
Total	100.00	100.00
Sulfur	2.99	2.93
Coke	59.41	58 15
Specific gravity	1.328	
B. T. U. per pound	13,235.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3485.—Coal labeled "Coal No. 9, mine No. 2, Providence Coal Company, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analysis made January 14, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	4.93
Moisture lost on air-drying 1 hour at 105° C.	3.41	.....
Volatile combustible matter	36.90	36.32
Fixed carbon	51.10	50.30
Ash (brown)	8.59	8.45
Total	100.00	100.00
Sulfur	3.46	3.41
Coke	59.69	58.75
Specific gravity	1.324	
B. T. U. per pound	13,141.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3484.—Coal labeled "Coal No. 9, from No. 3 mine, Providence Mining Company, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. Sample consisted of about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analysis made January 10, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	4.48
Moisture lost on air-drying 1 hour at 105° C.	3.95	.....
Volatile combustible matter	37.89	37.68
Fixed carbon	48.41	48.14
Ash (brown)	9.75	9.70
Total	100.00	100.00
Sulfur	3.78	3.76
Coke	58.16	57.84
Specific gravity	1.355	
B. T. U. per pound	12,515	

(Analysis by J. S McHargue.)

Laboratory number, U. S. Bureau of Mines.....19,141
Operator .....Providence Mining Company
Mine .....No. 3 of Providence Mining Co.
State .....Kentucky
County .....Webster
Bed ..... No. 9
Town .....2-3 mile north of center of Providence, Ky.
On I. C. and L. & N. R. R.
Location in mine.....Room No. 8 on 2nd E. entry off main north
1,300 feet from shaft.
Method of sampling .....Standard
Net weight, grams 1223.5
Date of sampling 4-10-14
Date of laboratory sampling 4-20-14
Date of analysis 4-28-14
Collector .....A. F. Crider

Air-dry Loss, 2.9		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.75	5.60	.....	.....
	Volatile matter	38.30	37.18	39.38	44.00
	Fixed carbon	48.75	47.32	50.13	56.00
	Ash	10.20	9.90	10.49	.....
		100.00	100.00	100.00	100.00
Sulphur		4.45	4.32	4.58	5.12
Calorific Value	Calories	7078	6871	7278	8131
	B. T. U.	12740	12368	13100	14636
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1980	90	100	195

Laboratory number, U. S. Bureau of Mines.....19,142
Operator .....Providence Mining Co.
Mine .....No. 3 of Providence Mining Co.
State ..... Kentucky
County ..... Webster
Bed ..... No. 9
Town.....2-3 mile north of Providence, Ky., on I. C. and L. & N. R. R.
Location in mine .....Face of room No. 8 off 2nd west entry, off main north entry. 1,200 feet from shaft.
Method of sampling .....Standard
Net weight, grams 1211.3
Date of sampling 4-10-14
Date of laboratory sampling 4-20-14
Date of analysis 5-7-14
Collector .....A. F. Crider

Air-dry Loss, 3.1		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.10	6.10	.....	.....
	Volatile matter	37.90	36.73	39.12	44.62
	Fixed carbon	47.05	45.59	48.55	55.38
	Ash	11.95	11.58	12.33	.....
		100.00	100.00	100.00	100.00
Sulphur		4.21	4.08	4.35	4.96
Calorific Value	Calories	6853	6641	7073	8067
	B. T. U.	12335	11954	12731	14521
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1870	50	90	194

Laboratory number, U. S. Bureau of Mines.....19,143
Operator .....Providence Mining Co.
Mine .....No. 3 of Providence Mining Co.
State ..... Kentucky
County ..... Webster
Bed ..... No. 9
Town.....2-3 mile north of Providence, Ky., on I. C. and L. & N. R. R.
Location in mine.....Face of No. 14 room off 2nd west entry off main north entry. 1,450 feet from shaft.
Method of sampling .....Standard
Net weight, grams 1193.2
Date of sampling 4-10-14
Date of laboratory sampling 4-20-14
Date of analysis 5-7 14
Collector .....A. F. Crider

Air-dry Loss, 2.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.80	5.55	.....	.....
	Volatile matter	39.05	37.94	40.17	44.01
	Fixed carbon	49.67	48.27	51.11	55.99
	Ash	8.48	8.24	8.72	.....
		100.00	100.00	100.00	100.00
Sulphur		2.80	2.72	2.88	3.16
Calorific Value	Calories	722	7017	7430	8140
	B. T. U.	12998	12631	13374	14652
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2050	230	140	200

Laboratory number, U. S. Bureau of Mines.....19,144
Operator .....Providence Mining Co.
Mine .....Providence Mining Co., No. 3 Mine
State .....Kentucky
County .....Webster
Bed .....No. 9
Town .....2-3 mile north of center of Providence, Ky., Mine I. C. R. R.
Location in mine.....Face of No. 6 room off 3rd west entry off main north entry. 1,500 feet from shaft bottom.
Method of sampling .....Standard
Date of sampling 4-10-14
Date of laboratory sampling 4-20-14
Date of analysis 4-29-14
Collector .....A. M. Hams

Air-dry Loss, 2.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.43	4.95	.....	.....
	Volatile matter	38.22	37.23	39.17	44.47
	Fixed carbon	47.72	46.49	48.91	55.53
	Ash	11.63	11.33	11.92	.....
		100.00	100.00	100.00	100.00
Sulphur		5.75	5.60	5.89	6.69
Calorific Value	Calories	6958	6778	7131	8096
	B. T. U.	12524	12200	12836	14573
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1980	70	50	203

Laboratory number, U. S. Bureau of Mines.....19,145
Operator .....Providence Mining Co.
Mine .....Providence Mining Co., No. 3 Mine
State .....Kentucky
County .....Webster
Bed .....No. 9
Town.....2-3 mile north of center of Providence, Ky., Mine No. 3 I. C. R. R.
Location in mine.....In last break through in No. 19 room off 1st west entry off north main entry. 1,500 feet from shaft.
Method of sampling .....Standard
Net weight, grams.....1236.6
Date of sampling 4-10-14
Date of laboratory sampling 4-21-14
Date of analysis 4-29-14
Collector .....A. M. Hams

Air-dry Loss, 2.5		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.10	5.51	.....	.....
	Volatile matter	37.45	36.52	38.65	43.52
	Fixed carbon	48.60	47.39	50.15	56.48
	Ash	10.85	10.58	11.20	.....
		100.00	100.00	100.00	100.00
Sulphur		3.65	3.56	3.77	4.25
Calorific Value	Calories	6978	6804	7201	8109
	B. T. U.	12560	12247	12962	14596
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2100	140	160	210

Laboratory number, U. S. Bureau of Mines.....19,146
Operator .....Providence Mining Co.
Mine .....Providence Mining Co., No. 3 Mine
State .....Kentucky
County .....Webster
Bed .....No. 9
Town.....2-3 mile north of center of Providence, Ky., Mine. I. C. R. R.
Location in mine .....Face of main north entry
1,500 feet from shaft bottom.
Method of sampling .....Standard
Net weight, grams 1247.0
Date of sampling 4-10-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector .....A. M. Hams

Air-dry Loss, 2.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.80	5.28	.....	.....
	Volatile matter	38.95	37.96	40.07	43.86
	Fixed carbon	49.85	48.57	51.28	56.14
	Ash	8.40	8.19	8.65	.....
		100.00	100.00	100.00	100.00
Sulphur		3.43	3.34	3.53	3.86
Ultimate Value	Calories	7249	7064	7457	8163
	B. T. U.	13048	12715	13423	14693
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1960	110	70	194

Laboratory number, U. S. Bureau of Mines.....19,147
Operator .....Providence Mining Co.
Mine .....Providence Mining Co., No. 3 Mine
State ..... Kentucky
County ..... Webster
Bed ..... No. 9
Town.....2-3 mile north of center of Providence, Ky., Mine. I. C. R. R.
Location in mine .....Comp. of 19141, 2, 3, 4, 5 and 6
Date 4-29-14
Collector .....A. W. Harris

Air-dry Loss, 2.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.95	5.62	.....	.....
	Volatile matter	28.25	37.20	39.41	44.09
	Fixed carbon	48.51	47.17	49.98	55.91
	Ash	10.29	10.01	10.61	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.06	5.23	4.88	5.46
	Carbon	70.02	68.09	72.14	80.70
	Nitrogen	1.47	1.43	1.52	1.70
	Oxygen	9.16	11.35	6.73	7.53
	Sulphur	4.00	3.89	4.12	4.61
	Ash	10.29	10.01	10.61	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7044	6850	7256	8120
	B. T. U.	12679	12330	13064	14616

Laboratory No. G-3490.—Coal, No. 9, from J. F. Wood's mine at Marksville, Webster County, Ky. Collected by L. C. Glenn. Analyzed November 23, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture	1.68
Volatile combustible mater	38.92
Fixed carbon	49.15
Ash	10.25
Total	100.00
Sulfur	4.01
Coke	59.40
Specific gravity	1.368
B. T. U. per pound	12,889.
Moisture lost on air-drying	1.04

(Analysis by J. S. McHargue.)

Laboratory No. 2668—Locality, Webster County, Ky. Sample labeled "Sebree Coal Co., Sebree, Ky." Sent by the Sebree Coal Co. Sample a sack partly filled with about a peck of clean, good looking black lump coal.

Analysis of the Air Dried Sample.	Per Cent
Moisture	8.87
Volatile combustible matter	40.62
Fixed carbon	45.52
Ash (light brown)	4.99
Total	100.00
Sulphur	2.29
Coke (spongy)	50.51
Specific gravity	1.301

S. D. Averett, Chemist.

Laboratory No. 3492.—Locality, Webster County, Ky. No. 9 coal from Sebree Coal & Mining Co.'s mine, Sebree, Ky. Collected by L. C. Glenn. 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	4.53
Moisture 104°-107° C.	4.59
Volatile combustible matter	38.00
Fixed carbon	46.94
Ash (brown)	10.47
Total	100.00
Sulfur	3.74
Coke (porous and friable)	57.41
Specific gravity	1.369

J. S. McHargue, Chemist.

Laboratory number, U. S. Bureau of Mines.....18,967
Operator .....Sebree Coal and Development Co.
Mine .....Sebree Coal Co.
State .....Kentucky
County .....Webster
Bed .....No. 9
Town .....½ mile north of Sebree on the L. & N. R. R.
Location in mine.....From last entry off air course of 2nd north entry, off main east entry. 1,400 feet from shaft.
Method of sampling .....Standard
Net weight, grams 1193.6
Date of sampling 3-26-14
Date of laboratory sampling 4-4-14
Date of analysis 4-16-14
Collector .....J. T. Ryan

Air-dry Loss, 3.1		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	7.80	10.66	.....	.....
	Volatile matter	38.20	37.02	41.44	46.09
	Fixed carbon	44.70	43.31	48.48	53.91
	Ash	9.30	9.01	10.08	.....
		100.00	100.00	100.00	100.00
Sulphur		3.23	3.13	3.50	3.89
Calorific Value	Calories	6602	6397	7160	7963
	B. T. U.	11884	11515	12888	14333
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2020	90	170	164

Laboratory number, U. S. Bureau of Mines.....18,968
Operator .....Sebree Coal and Development Co.
Mine .....Sebree Coal Co.
State ..... Kentucky
County ..... Webster
Bed ..... No. 9
Town .....½ mile north of Sebree on L. & N. R. R
Location in mine.....Face of 3rd north entry off east entry
1,600 feet from shaft.
Method of sampling .....Standard
Net weight, grams 1230.5
Date of sampling 3-26-14
Date of laboratory sampling 4-4-14
Date of analysis 4-14-14
Collector .....J. T. Ryan

Air-dry Loss, 2.5		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	7.40	9.70	.....	.....
	Volatile matter	38.00	37.06	41.04	46.68
	Fixed carbon	43.40	42.32	46.87	53.32
	Ash	11.20	10.92	12.09	.....
		100.00	100.00	100.00	100.00
Sulphur		3.90	3.80	4.21	4.79
Calorific Value	Calories	6391	6233	6902	7851
	B. T. U.	11504	11219	12424	14132
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1810	120	100	182

Laboratory number, U. S. Bureau of Mines.....18,969F
Operator .....Sebree Coal and Development Co.
Mine .....Sebree Coal Co.
State ..... Kentucky
County ..... Webster
Bed ..... No. 9
Town .....½ mile north of Sebree on L. & N. R. R.
Location in mine .....Comp. of 18,967 and 18,968
Date of analysis 4-16-14
Collector .....J. T. Ryan

Air-dry Loss, 2.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	7.50	10.08	.....	.....
	Volatile matter	38.20	37.13	41.29	46.41
	Fixed carbon	44.10	42.87	47.68	53.59
	Ash	10.20	9.92	11.03	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.23	5.39	4.75	5.34
	Carbon	65.06	63.24	70.33	79.05
	Nitrogen	1.40	1.36	1.51	1.70
	Oxygen	14.54	16.62	8.52	9.57
	Sulphur	3.57	3.57	3.86	4.34
	Ash	10.20	9.92	11.03	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	6499	6318	7026	7897
	B. T. U.	11698	11372	12647	14215

ANALYSES OF COAL NO. 11.

Laboratory number, U. S. Bureau of Mines.....1,382
Operator .....West Kentucky Coal Co.
Mine ..... Wheatcroft
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... Wheatcroft
Location in mine .....Room 8 off west shaft entry, 70-inch cut

Air-dry Loss, 2.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	.....	4.61	.....	.....
	Volatile matter	.....	38.17	40.01	43.37
	Fixed carbon	.....	49.82	52.23	56.63
	Ash	.....	7.40	7.76	.....
		.....	100.00	100.00	100.00
Sulphur		.....	3.33	3.49	3.78
Calorific Value	Calories	.....	7145	7490	8120
	B. T. U.	.....	12861	13482	14616

Laboratory number, U. S. Bureau of Mines.....1,384
Operator .....West Kentucky Coal Co.
Mine ..... Wheatcroft
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... Wheatcroft
Location in mine .....West entry 2, 65-inch cut

Air-dry Loss, 2.0		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	.....	4.76	.....	.....
	Volatile matter	.....	39.72	41.71	45.02
	Fixed carbon	.....	48.51	50.93	54.98
	Ash	.....	7.01	7.36	.....
		.....	100.00	100.00	100.00
Sulphur		.....	3.21	3.37	3.64

Laboratory number, U. S. Bureau of Mines.....1,539
Operator .....West Kentucky Coal Co.
Mine ..... Wheatcroft
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... Wheatcroft
Location in mine.....Run of mine

Air-dry Loss, 2.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	.....	5.27	.....	.....
	Volatile matter	.....	35.07	37.02	43.54
	Fixed carbon	.....	45.48	48.01	56.46
	Ash	.....	14.18	14.97	.....
		.....	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	.....	4.71	4.35	5.10
	Carbon	.....	64.65	68.24	80.26
	Nitrogen	.....	1.24	1.31	1.54
	Oxygen	.....	10.68	6.34	7.46
	Sulphur	.....	4.54	4.79	5.64
	Ash	.....	14.18	14.97	.....
		.....	100.00	100.00	100.00
Calorific Value	Calories	.....	6639	7009	8242
	B. T. U.	.....	11950	12614	14836

Laboratory number, U. S. Bureau of Mines.....19,119
Operator .....West Kentucky Coal Co.
Mine .....West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town .....1,000 feet west of Wheatcroft station
Location in mine.....Face No. 64, room off 5th west entry
5,100 feet from entrance.
Method of sampling .....Standard
Net weight, grams 1249.7
Date of sampling 4-8-14
Date of laboratory sampling 4-16-14
Date of analysis 4-24-14
Collector .....A. M. Hams

Air-dry Loss, 2.1		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.15	4.24	.....	.....
	Volatile matter	39.03	38.19	39.88	45 29
	Fixed carbon	47.13	46.13	48.17	54.71
	Ash	11.69	11.44	11.95	.....
		100.00	100.00	100.00	100.00
Sulphur		4.19	4.10	4.28	4.86
Calorific Value	Calories	7104	6952	7260	8245
	B. T. U.	12787	12514	13068	14841
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2080	70	140	210

Laboratory number, U. S. Bureau of Mines.....19,120
Operator .....West Kentucky Coal Co.
Mine .....West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town .....1,000 feet west from Weatcroft, Ky.
Location in mine.....Face of No. 114 room, 6th west entry approx. 3,000 feet from entrance.
Method of sampling .....Standard
Net weight, grams 1264.7
Date of sampling 4-8-14
Date of laboratory sampling 4-16-14
Date of analysis 4-24-14
Collector .....A. M. Hams

Air-dry Loss, 2.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.20	4.95	.....	.....
	Volatile matter	37.84	36.78	38.70	42.87
	Fixed carbon	50.44	49.02	51.57	57.13
	Ash	9.52	9.25	9.73	.....
		100.00	100.00	100.00	100.00
Sulphur		4.00	3.89	4.09	4.53
Calorific Value	Calories	7286	7081	7450	8253
	B. T. U.	13115	12746	13410	14855
		S. T.	S. I.	S. I.	Sheet
Softening Temperature of Ash.	° F.	2390	200	60	200

Laboratory number, U. S. Bureau of Mines.....19,121
Operator .....West Kentucky Coal Co.
Mine .....West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town .....1,000 feet west of Wheatcroft Station, Ky.
Location in mine.....Along left rib of 5th west entry 5,100 feet from entrance.
Method of sampling .....Standard
Net weight, grams 1170.3
Date of sampling 4-8-14
Date of laboratory sampling 4-16-14
Date of analysis 4-24-14
Collectors .....A. M. Hams and A. F. Crider

Air-dry Loss, 2.0		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.20	4.17	.....	.....
	Volatile matter	39.28	38.49	40.16	44.20
	Fixed carbon	49.58	48.58	50.70	55.80
	Ash	8.94	8.76	9.14	.....
		100.00	100.00	100.00	100.00
Sulphur		3.88	3.80	3.97	4.37
		S. T.	S. I.	F. I.	Sheet
Calorific Value	Calories	7307	7160	7471	8223
	B. T. U.	13153	12888	13448	14801
Softening Temperature of Ash.	° F.	2100	140	80	215

Laboratory number, U. S. Bureau of Mines 19,122
Operator ..... West Kentucky Coal Co.
Mine ..... West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... Located in town of Wheatcroft, Ky., on I. C. R. R.
Location in mine ..... Face of 4th west entry, 5,000 feet from entrance
Method of sampling ..... Standard
Net weight, grams 1290.9
Date of sampling 4-8-14
Date of laboratory sampling 4-16-14
Date of analysis 4-25-14
Collector ..... A. F. Crider

Air-dry Loss, 1.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.05	3.81	.....	.....
	Volatile matter	38.50	37.81	39.31	44.04
	Fixed carbon	48.92	48 04	49.94	55.96
	Ash	10.53	10.34	10.75	.....
		100.00	100.00	100.00	100.00
Sulphur		4.06	3.99	4.15	4.65
Calorific Value	Calories	7184	7055	7334	8217
	B. T. U.	12931	12699	13201	14791
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2210	270	130	210

Laboratory number, U. S. Bureau of Mines.....19,123
Operator .....West Kentucky Coal Co.
Mine .....West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town .....Located in town of Wheatcroft, Ky., on I. C. R. R.
Location in mine.....Rib face of 6th east air course
2,800 feet from entrance.
Method of sampling .....Standard
Net weight, grams 1174.1
Date of sampling 4-8-14
Date of laboratory sampling 4-16-14
Date of analysis 4-25-14
Collector .....A. F. Crider

Air-dry Loss, 1.4		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.85	4.16	.....	.....
	Volatile matter	37.95	37.44	39.06	43.72
	Fixed carbon	48.83	48.17	50.27	56.28
	Ash	10.37	10.23	10.67	.....
		100.00	100.00	100.00	100.00
Sulphur		4.07	4.02	4.19	4.69
Ultimate Analysis	Calories	7134	7038	7343	8220
	B. T. U.	12841	12668	13217	14796
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2020	100	260	213

Laboratory number, U. S. Bureau of Mines.....19,124
Operator .....West Kentucky Coal Co.
Mine .....West Kentucky Coal Co., No. 4
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town .....1,000 feet west of Wheatcroft Station
Location of mine.....Comp. of 19,119, 20, 21, 22 and 23
Date of Cal. 4-25-21
Collector .....A. W. Harris

Air-dry Loss, 2.0		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.30	4.27	.....	.....
	Volatile matter	38.84	38.06	39.76	44.44
	Fixed carbon	48.56	47.58	49.70	55.56
	Ash	10.30	10.09	10.54	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.10	5.22	4.96	5.54
	Carbon	70.92	69.49	72.59	81.14
	Nitrogen	1.46	1.43	1.49	1.67
	Oxygen	8.15	9.78	6.25	6.99
	Sulphur	4.07	3.99	4.17	4.66
	Ash	10.30	10.09	10 54	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7186	7041	7355	8221
	B. T. U.	12935	12674	13239	14798

Laboratory No. G-2788.—Coal, No. 11, as follows:

No. 1, labeled "Webster County, Wheatcroft mine (shaft) now West Kentucky Coal Company's colliery A. Taken in head of west entry on course. Coal 11", sulfur ½", fire clay 3", coal 18", thickness 63½". A. G. S."

No. 2, labeled similarly, except "from room 11 on main west entry. Coal 11", sulfur ½", coal 30", fire clay 2", coal 14", sulfur 1", coal 7". Thickness 65½"."

Composite sample of the above two samples made for analysis. Analyzed June 17, 1907.

Analysis of the Air Dried Sample.	Per Cent
Moisture	2.46
Ash (pink)	10.54
B. T. U. per pound	12,708.
Total carbon	68.1
Sulfur (gravimetric)	4 36

(Analysis by Edgar and Brockman.)

Laboratory No. 3494.—Locality, Webster County, Ky. Mine No. 3 (No. 11 coal), West Kentucky Coal Co., Wheatcroft, Ky. Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.14
Moisture 104°-107° C.	2.06
Volatile combustible matter	38.36
Fixed carbon	50.66
Ash (brown)	8.92
Total	100.00
Sulphur	3.14
Coke (porous and friable)	59.58
Specific gravity	1.352

J. S. McHargue, Chemist.

Laboratory No. 3558.—Locality, Webster County, Ky. Wheatcroft, mine No. 4, West Kentucky Coal Co. Collected by L. C. Glenn, 1911. No. 11 coal.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	0.704
Moisture at 104°-107° C.	2.40
Volatile combustible matter	39.18

Fixed carbon	49.41
Ash (reddish)	9.01
Total	100.00
Sulphur	3.70
Coke (porous and friable)	58.42
Specific gravity	1.359

J. S. McHargue, Chemist.

Laboratory No. .....—Locality, Webster County, Ky., Wheatcroft mine (shaft), now West Kentucky Coal Co.'s colliery G. Thickness of bed 63½ inches. Collected by A. G. Spillman, December 16, 1904. Taken in head at west entry air course. Coal 11 inches, sulphur ½", coal 2 ft. 7 ins , fire clay 3", coal 1 ft. 6 ins. No. 11 coal.

Analysis of the Air Dried Sample.	Per Cent
Moisture	1.16
Volatile combustible matter	37.94
Fixed carbon	51.17
Ash (purple)	9.73
Total	100.00
Sulphur	3.91
Coke (spongy)	60.90
Specific gravity	1.42

Chas. Palmer, Chemist.

Laboratory No. .....—Locality, Webster County, Ky., Wheatcroft mine from room No. 11 on main west entry, now West Kentucky Coal Co.'s colliery G. Thickness of bed 65½ inches. Collected by A. G. Spillman, December 16, 1904. Coal 11", sulphur ½", coal 2' 6", fire clay 2", coal 14", sulphur 1", coal 7" No. 11 coal.

Analysis of the Air Dried Sample.	Per Cent
Moisture	1.18
Volatile combustible matter	39.62
Fixed carbon	50.17
Ash (purple)	9.03
Total	100.00
Sulphur	3.19
Coke (spongy)	59.20
Specific gravity	1.30

Chase Palmer, Chemist.

Laboratory No. 3495.—Locality, Webster County, Ky., No. 11 coal from S. E. Lever's mine, 2 miles northwest of Providence, Ky. Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.62
Moisture 104°-107° C.	3.07
Volatile combustible matter	37.11
Fixed carbon	50.36
Ash (brown)	9.46
Total	100.00
Sulphur	3.05
Coke (porous and friable)	59.82
Specific gravity	1.342

J. S. McHargue, Chemist.

Laboratory No. G-3479.—Coal, labeled "Coal No. 11 from Gaines Coal Company's mine at Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed. Received in a sealed glass jar. Analyzed January 10, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	4.85
Moisture lost on air-drying 1 hour at 105° C.	3.98	.....
Volatile combustible matter	37.55	37.21
Fixed carbon	50.69	50.23
Ash (brown)	7.78	7.71
Total	100.00	100.00
Sulfur	3.94	3.90
Coke	58.47	57.94
Specific gravity	1.338	
B. T. U. per pound	13,328.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3486.—Coal, labeled "Coal No. 11, Webster County Coal Company, Providence, Webster County, Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1½ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analysis made December 14, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.20
Moisture lost on air-drying 1 hour at 105° C.	2.71	.....
Volatile combustible matter	40.85	39.81

Analysis	Air Dried	As Received
Fixed carbon	47.87	46.64
Ash (brown)	8.57	8.35
Total	100.00	100.00
Sulfur	3.10	3.02
Coke	56.44	54.99
Specific gravity	1.312	
B. T. U. per pound	13,328.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3475.—Coal, labeled "Coal No. 11, Shamrock mine, Providence, Ky., Webster County. St. Bernard Mining Co., Earlington, Hopkins Co., Ky." Collected by L. C. Glenn, 1911. The sample consisted of about 1¾ lbs. of small lumps and fine coal mixed, received in a sealed glass jar. Analyzed January 10, 1912.

Analysis.	Air Dried	As Received
Moisture lost on air-drying 36 hours	.....	5.83
Moisture lost on air-drying 1 hour at 105° C.	4.17	.....
Volatile combustible matter	38.10	37.44
Fixed carbon	49.56	48.70
Ash (brown)	8.17	8.03
Total	100.00	100.00
Sulfur	3.27	3.21
Coke	57.73	56.73
Specific gravity	1.309	
B. T. U. per pound	13,390.	

(Analysis by J. S. McHargue.)

Laboratory No. G-3082.—Coal No. 11, labeled "Coal, Shamrock mine, Providence, Webster County, near face of 2nd west entry." Average sample of medium sized lump coal, having a black glossy luster. A few scales of calcite were observed. Some slate was found. A very good looking grade of coal. Collected by Spillman. Analyzed June 29, 1909.

Analysis	Per Cent
Moisture	3.70
Volatile combustible matter	40.38
Fixed carbon	49.97
Ash (lilac)	5.95
Total	100.00
Sulfur	2.72
Specific gravity	1.291
Coke (porous, friable)	55.92
Phosphorus	trace

(Analysis by J. S. McHargue.)

Laboratory No. G-3087.—Coal No. 11, labeled "Coal from Shamrock mine near face of south entry in Webster County, Ky. Coal 46", clay 2", coal 24", total 72". Collected by A. G. Spillman." Average sample of medium sized lump coal, black glossy luster. No impurities observed. Contained very little coal dust. Analyzed June 29, 1909.

Analysis	Per Cent
Moisture	3.70
Volatile combustible matter	40.45
Fixed carbon	50.98
Ash (lilac, contains CO^2)	4.87
Total	100.00
Sulfur	2.77
Specific gravity	1.304
Phosphorus	trace
Coke (porous and friable)	55.85

(Analysis by J. S. McHargue.)

Laboratory number, U. S. Bureau of Mines.....19,176
Operator .....St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine .....Face of room No. 45 off northwest entry 2,700 feet from shaft.
Net weight, grams 894.5
Date of sampling 4-14-14
Date of laboratory sampling 4-22-14
Date of analysis 5-20-14
Collector .....A. F. Crider

Air-dry Loss, 2.7		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.35	5.94	.....	.....
	Volatile matter	38.35	37.32	39.68	44.37
	Fixed carbon	48.10	46.81	49.76	55.63
	Ash	10.20	9.93	10.56	.....
		100.00	100.00	100.00	100.00
Sulphur		3.94	3.83	4.07	4.55
Calorific Value	Calories	6944	6758	7185	8034
	B. T. U.	12499	12164	12933	14461
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1970	160	220	164
	° F.	2040	140	140	179

Laboratory number, U. S. Bureau of Mines.....19,177
Operator .....St. Bernard Mining Co.
Mine .....Shamrock
State .....Kentucky
County .....Webster
Bed .....No. 11
Town .....1½ miles northwest of Providence, Ky., on L. & N. R. R.
Location in mine .....Face of room No. 8 off 5th west entry 2,000 feet from shaft.
Method of sampling .....Standard
Net weight, grams 876.8
Date of sampling 4-13-14
Date of laboratory sampling 4-22-14
Date of analysis 5-19-14
Collector .....A. F. Crider

Air-dry Loss, 2.3		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.45	5.71	.....	.....
	Volatile matter	39.50	38.58	40.92	44.64
	Fixed carbon	49.00	47.85	50.74	55.36
	Ash	8.05	7.86	8.34	.....
		100.00	100.00	100.00	100.00
Sulphur		3.67	3.58	3.80	4.15
Calorific Value	Calories	7174	7006	7431	8107
	B. T. U.	12913	12611	13376	14593
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2110	280	80	185

Laboratory number, U. S. Bureau of Mines.....19,178
Operator .....St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine .....Rib face of room No. 24 off 4th southeast entry 3,000 feet from shaft.
Method of sampling .....Standard
Net weight, grams 878.3
Date of sampling 4-14-14
Date of laboratory sampling 4-22-14
Date of analysis 5-20-14
Collector .....A. F. Crider

Air-dry Loss, 2.4		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.35	5.71	.....	.....
	Volatile matter	39.55	38.58	40.92	45 81
	Fixed carbon	46.79	45.65	48.41	54.19
	Ash	10.31	10.06	10.67	.....
		100.00	100.00	100.00	100.00
Sulphur		4.06	3.96	4.20	4.70
Calorific Value	Calories	6912	6743	7152	8006
	B. T. U.	12442	12137	12874	14411
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1960	120	80	197

Laboratory number, U. S. Bureau of Mines 19,179
Operator ..... St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... 1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine ..... Face of room No. 29 off 3rd northwest entry 2,500 feet from shaft bottom.
Net weight, grams 862 3
Date of sampling 4-13-14
Date of laboratory sampling 4-23-14
Date of analysis 5-20-14
Collector ..... A. F. Crider

Air-dry Loss, 2.7		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3 00	5.63	.....	.....
	Volatile matter	39.80	38.72	41.03	45.09
	Fixed carbon	48.47	47.16	49.97	54.91
	Ash	8.73	8.49	9.00	.....
		100.00	100.00	100.00	100.00
Sulphur		3.82	3.72	3.94	4.35
Calorific Value	Calories	7140	6947	7362	8090
	B. T. U.	12852	12505	13252	14562
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1960	80	80	194

Laboratory number, U. S. Bureau of Mines 19,180
Operator ..... St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed ..... No. 11
Town ..... 1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine ..... Rib face off 7th northeast entry 2,000 feet from shaft.
Method of sampling ..... Standard
Net weight, grams 815.7
Date of sampling 4-13-14
Date of laboratory sampling 4-23-14
Date of analysis 5-20-14
Collector ..... A. F. Crider

Air-dry Loss, 2.3		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.50	5.75		
	Volatile matter	39.40	38.48	40.83	44.89
	Fixed carbon	48.37	47.24	50.12	55.11
	Ash	8.73	8.53	9.05	
		100.00	100.00	100.00	100.00
Sulphur		3.64	3.56	3.78	4.16
Calorific Value	Calories	7076	6911	7333	8063
	B. T. U.	12737	12440	13199	14513
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1960	110	180	192

Laboratory number, U. S. Bureau of Mines.....19,181
Operator .....St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine.....Face of room No. 46 off 1st southeast entry 3,500 feet from shaft.
Method of sampling .....Standard
Net weight, grams 857.0
Date of sampling 4-14-14
Date of laboratory sampling 4-23-14
Date of analysis 5-21-14
Collector .....A. F. Crider

Air-dry Loss, 2.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.00	5.49	.....	.....
	Volatile matter	39.80	38.78	41.03	45.24
	Fixed carbon	48.17	46.93	49.66	54.76
	Ash	9.03	8.80	9.31	.....
		100.00	100.00	100.00	100.00
Sulphur		4.04	3.94	4.17	4.60
Calorific Value	Calories	7058	6877	7277	8024
	B. T. U.	12704	12379	13099	14443
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1950	60	100	199

Laboratory number, U. S. Bureau of Mines.....19,182
Operator .....St. Bernard Mining Co.
Mine .....Shamrock
State .....Kentucky
County .....Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine .....Last break through 1st northeast entry 2,100 feet from shaft bottom.
Method of sampling .....Standard
Net weight, grams 876.9
Date of sampling 4-14-14
Date of laboratory sampling 4-23-14
Date of analysis 5-16-14
Collector .....A. M Hams

Air-dry Loss, 3.2		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.60	6.67	.....	.....
	Volatile matter	38.15	36 94	39.58	43.99
	Fixed carbon	48.58	47.03	50.39	56.01
	Ash	9.67	9.36	10.03	.....
		100.00	100.00	100.00	100.00
Sulphur		4.58	4.43	4.75	5.28
Calorific Value	Calories	6975	6753	7236	8043
	B. T. U.	12555	12155	13025	14477
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1930	80	70	197

Laboratory number, U. S. Bureau of Mines.....19,183
Operator .....St. Bernard Mining Co.
Mine ..... Shamrock
State ..... Kentucky
County ..... Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location of mine .....Face of 5th northeast entry
2,400 feet from shaft bottom.
Method of sampling .....Standard
Net weight, grams 871.7
Date of sampling 4-14-14
Date of laboratory sampling 4-23-14
Date of analysis 5-20-14
Collector .....A. M. Hams

Air-dry Loss, 2.5		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.20	5.59	.....	.....
	Volatile matter	37.95	37.01	39.20	44.14
	Fixed carbon	48.02	46.84	49.61	44.86
	Ash	10.83	10.56	11.19	.....
		100.00	100.00	100.00	100.00
Sulphur		4.98	4.86	5.15	5.80
Calorific Value	Calories	6916	6745	7144	8044
	B. T. U.	12449	12141	12859	14479
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1880	80	130	195

Laboratory number, U. S. Bureau of Mines.....19,184
Operator .....St. Bernard Mining Co.
Mine .....Shamrock
State .....Kentucky
County .....Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine ....Face of 3rd northeast. 2,300 feet from shaft bottom
Method of sampling .....Standard
Net weight, grams 854.8
Date of sampling 4-14-14
Date of laboratory sampling 4-23-14
Date of analysis 5-16-14
Collector .....A. M. Hams

Air-dry Loss, 3.9		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.75	7.48	.....	.....
	Volatile matter	38.45	36.96	39.95	44.27
	Fixed carbon	48.41	46.53	50.29	55.73
	Ash	9.39	9.03	9.76	.....
		100.00	100.00	100.00	100.00
Sulphur		4.14	3.98	4.30	4.77
Calorific Value	Calories	7011	6739	7284	8072
	B. T. U.	12620	12130	13111	14530
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	1990	90	80	202

Laboratory number, U. S. Bureau of Mines.....19,185
Operator .....St. Bernard Mining Co.
Mine .....Shamrock
State .....Kentucky
County .....Webster
Bed .....No. 11
Town .....1½ miles northeast of Providence, Ky., on L. & N. R. R.
Location in mine.....Comp. of -19,176, 77, 78, 79, 80, 81, 82, 83 and 84
Date of analysis 5-20-14
Collector .....A. W. Harris

Air-dry Loss, 2.7		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.36	6.00	.....	.....
	Volatile matter	38.94	37.88	40.30	44.73
	Fixed carbon	48.12	46.80	49.79	55.27
	Ash	9.58	9.32	9.91	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.10	5.26	4.88	5.42
	Carbon	70.12	68.21	72.56	80.64
	Nitrogen	1.35	1.31	1.39	1.54
	Oxygen	9.75	11.91	7.02	7.79
	Sulphur	4.10	3.99	4.24	4.71
	Ash	9.58	9.32	9.91	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7019	6827	7263	8062
	B. T. U.	12634	12289	13073	14512

ANALYSIS OF COAL NO. 12.

Laboratory No. G-3491.—Coal No. 12, from Marks mine, Marksville, Webster County, Ky. Collected by L. C. Glenn. Analyzed November 23, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture	1.96
Volatile combustible matter	41.40
Fixed carbon	47.55
Ash	9.09
Total	100.00
Sulfur	4.44
Coke	56.64
Specific gravity	1.360
B. T. U. per pound	13,013.
Moisture lost on air-drying	1.60

(Analysis by J. S. McHargue.)

ANALYSIS OF COAL NO. 14.

Laboratory No. 3557.—Locality, Webster County, Ky., Coal No. 14 from the Baker, or No. 5 mine, West Kentucky Coal Co., near Clay, Ky. Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	2.27
Moisture at 104°-107° C.	2.92
Volatile combustible matter	35.83
Fixed carbon	52.03
Ash (brown)	9.22
Total	100.00
Sulphur	2.03
Coke (porous and friable)	61.25
Specific gravity	1.302

J. S. McHargue, Chemist.

Laboratory number, U. S. Bureau of Mines.....10,480
Barrel C.
Operator .....West Kentucky Coal Co.
Mine .....No. 5
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town.....1½ miles west of Clay on I. C. R. R.
Date of sampling 5-6-10
Collector .....R. Y. Williams

Air-dry Loss 2.7		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.58	6.18	.....	.....
	Volatile matter ..	34.48	33.55	35.76	39.25
	Fixed carbon	53.38	51.93	55.36	60.75
	Ash	8.56	8.33	8.88	.....
		100.00	100.00	100.00	100.00
Sulphur		1.25	1.22	1.30	1.43
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2520	150	80	.....

Laboratory number, U. S. Bureau of Mines.....10,481
Barrel A.
Operator .....West Kentucky Coal Co.
Mine .....No. 5
State ..... Kentucky
Bed ..... No. 14
County ..... Webster
Town.....1½ miles west of Clay on I. C. R. R.
Date of sampling 5-6-10
Collector .....R. Y. Williams

Air-dry Loss, 1.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.30	4.83	.....	.....
	Volatile matter	36.22	35.65	37.45	41.14
	Fixed carbon	51.80	50.98	53.58	58.86
	Ash	8.68	8.54	8.97	.....
		100.00	100.00	100.00	100.00
Sulphur		2.21	2.18	2.29	2 52

Laboratory number, U. S. Bureau of Mines.....10,482

Barrel B.

Operator .....West Kentucky Coal Co.
Mine .....No. 5
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town.....1½ miles west of Clay on I. C. R. R.
Date of sampling 5-6-10
Collector .....R. Y. Williams

Air-dry Loss, 1.6		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.41	4.96	.....	.....
	Volatile matter ..	34.99	34.43	36.23	40.26
	Fixed carbon	51.94	51.10	53.76	59.74
	Ash	9.66	9 51	10.01	.....
		100.00	100.00	100.00	100.00
Sulphur		2.11	2.08	2.19	2.43
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2370	330	70	.....

Laboratory number, U. S. Bureau of Mines 10,483
Barrel A-B-C.
Operator ..... West Kentucky Coal Co.
Mine ..... No. 5
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Location in mine ..... Composite of 10,481, 82 and 10,480

Air-dry Loss, 2.0		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.47	5.40	.....	.....
	Volatile matter	35.73	35.02	37.02	40.78
	Fixed carbon	51.89	50.85	53.75	59.22
	Ash	8.91	8.73	9 23	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.24	5.36	5.03	5.54
	Carbon	72.30	70.85	74.90	82 52
	Nitrogen	1.53	1.50	1.59	1.75
	Oxygen	10.09	11.67	7.25	7.99
	Sulphur	1.93	1.88	2.00	2.20
	Ash	8.91	8.73	9.23	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7210	7066	7469	8229
	B. T. U.	12978	12719	13444	14812

Laboratory No. 3493.—Locality, Webster county, Ky., No. 14 coal from Mine No. 7, West Kentucky Coal Co., 1 mile northwest of Clay, Ky. Collected by L. C. Glenn, 1911.

Analysis of the Air Dried Sample.	Per Cent
Moisture lost on air-drying 36 hours	1.74
Moisture 104°-107° C.	2.66
Volatile combustible matter	36.50
Fixed carbon	53.61
Ash (brown)	7.23
Total	100.00
Sulphur	1.29
Coke (porous and friable)	60.84
Specific gravity	1.333

J. S. McHargue, Chemist.

Laboratory number, U. S. Bureau of Mines.....19,148
Can number 35,511
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town.....1¼ miles north of west of Clay, Ky., on I. C. R. R.
Location in mine .....Face of west dip entry, air course 1,850 feet from shaft.
Method of sampling .....Standard
Net weight, grams 872.4
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector .....A. F. Crider

Air-dry Loss 2.9		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.94	5.73	.....	.....
	Volatile matter	37.21	36.14	38.34	41.67
	Fixed carbon	52.12	50.62	55.69	58.33
	Ash	7.73	7.51	7.97	.....
		100.00	100.00	100.00	100.00
Sulphur		2.06	2.00	2.12	2.30
Calorific Value	Calories	7388	7176	7612	8271
	B. T. U.	14298	12917	13702	14888
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2190	160	100	195

Laboratory number, U. S. Bureau of Mines.....19,149
Can number 23
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town.....1¼ miles north of west of Clay, Ky., on I. C. R. R.
Location in mine....Neck of break through between 3rd and 4th entries, off 2nd right entry. 1,600 feet from shaft.
Method of sampling .....Standard
Net weight, grams 853.9
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector .....A. F. Crider

Air-dry Loss, 2.4		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.90	5.24	.....	.....
	Volatile matter	37.05	36.16	38.16	40.94
	Fixed carbon	53.46	52.17	55.05	59.06
	Ash	6.59	6.43	6.79	.....
		100.00	100.00	100.00	100.00
Sulphur		1.33	1.30	1.37	1.47
Calorific Value	Calories	7458	7278	7680	8239
	B. T. U.	13424	13100	13823	14830
Softening Temperature of Ash.	° F.	2490	550	80	203

Laboratory number, U. S. Bureau of Mines 19,150
Can number 32
Operator ..... West Kentucky Coal Co.
Mine ..... No. 7
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town ..... 1¼ miles north of west of Clay, Ky., on I. C. R. R.
Location of mine ..... Face of 4th S. entry off 2nd left entry 2,800 feet from shaft.
Method of sampling ..... Standard
Net weight, grams 840.1
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector ..... A. F. Crider

Air-dry Loss, 3.4		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.09	6.38	.....	.....
	Volatile matter	35.71	34.50	36.85	41.18
	Fixed carbon	51.00	49.27	52.63	58.82
	Ash	10.20	9.85	10.52	.....
		100.00	100.00	100.00	100.00
Sulphur		1.13	1.09	1.16	1.30
		S. T.	S. I.	F. I.	Sheet
Calorific Value	Calories	7091	6850	7316	8176
	B. T. U.	12764	12330	13169	14717
Softening Temperature of Ash.	° F.	2260	230	90	198
	° F.	2240	240	120	213

Laboratory number, U. S. Bureau of Mines.....19,151
Can number 34
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town .....1¼ miles N. of W. of Clay, Ky.
Can inside label not correct for location.
Location of mine.....Face of No. 10 room off 1st left entry off west dip entry, 200 feet from shaft bottom.
Method of sampling .....Standard
Net weight, grams 856.2
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector .....A. M. Hams

Air-dry Loss, 2.5		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.27	5.65	.....	.....
	Volatile matter	36.26	35.37	37.49	40.47
	Fixed carbon	53.35	52.04	55.15	59.53
	Ash	7.12	6.94	7.36	.....
		100.00	100.00	100.00	100.00
Sulphur		1.20	1.17	1.24	1.34
Calorific Value	Calories	7386	7204	7636	8242
	B. T. U.	13295	12967	13745	14836
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2370	590	180	194

Laboratory number, U. S. Bureau of Mines 19,152
Can number 37
Operator ..... West Kentucky Coal Co.
Mine ..... No. 7
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town ..... 1¼ miles N. of W. Clay, Ky.
(Inside can label not correct on location.)
Location in mine ..... Face of room 1r, off 1st south entry, off 2nd right entry, 1,600 feet from shaft.
Method of sampling ..... Standard
Net weight, grams 887.1
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-7-14
Collector ..... A. M. Hams

Air-dry Loss, 2.5		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	2.71	5.09	.....	.....
	Volatile matter	37.09	36.18	38.12	41.91
	Fixed carbon	51.39	50.14	52.83	58.09
	Ash	8.81	8.59	9.05	.....
		100.00	100.00	100.00	100.00
Sulphur		2.85	2.78	2.93	3.22
Calorific Value	Calories	7272	7094	7474	8218
	B. T. U.	13090	12769	13455	14792
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2080	260	90	194

Laboratory number, U. S. Bureau of Mines 19,153
Can number 26
Operator ..... West Kentucky Coal Co.
Mine ..... No. 7
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town ..... 1¼ miles N. of W. Clay, Ky.
(Can inside label not correct.)
Location in mine ..... At face of 2nd left entry
3,000 feet from main shaft bottom.
Method of sampling ..... Standard
Net weight, grams 871.3
Date of sampling 4-9-14
Date of laboratory sampling 4-21-14
Date of analysis 5-8-14
Collector ..... A. M. Hams

Air-dry Loss, 2.4		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.53	5.80	.....	.....
	Volatile matter	34.22	33.42	35.48	39.11
	Fixed carbon	53.30	52.04	55.23	60.89
	Ash	8.95	8.74	9.28	.....
		100.00	100.00	100.00	100.00
Sulphur		1.16	1.13	1.20	1.32
Calorific Value	Calories	7168	7000	7431	8191
	B. T. U.	12902	12600	13376	14744
		S. T.	S. I.	F. I.	Sheet
Softening Temperature of Ash.	° F.	2290	270	90	198

Laboratory number, U. S. Bureau of Mines.....19,154F
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State ..... Kentucky
County ..... Webster
Bed .....No. 14
Town .....1¼ miles N. of W. Clay, Ky.
Location in mine .....Comp. 19148, 49, 50, 51, 52 and 53
Method of sampling .....Standard
Date of analysis 5-8-14
Collector .....A. W. Harris

Air-dry Loss, 2.7		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.00	5.58	.....	.....
	Volatile matter	36.00	35.04	37.11	40.58
	Fixed carbon	52.72	51.32	54.35	59.42
	Ash	8.28	8.06	8.54	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.16	5.32	4.98	5.45
	Carbon	73.44	71.49	75.72	82.79
	Nitrogen	1.54	1.50	1.59	1.74
	Oxygen	9.95	12.04	7.49	8.18
	Sulphur	1.63	1.59	1.68	1.84
	Ash	8.28	8.06	8.54	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7280	7086	7505	8206
	B. T. U.	13104	12755	13509	14771

Laboratory number, U. S. Bureau of Mines.....30,747
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town .....Clay on I. C. and L. &. R. R.
Location in mine.....Face 11 room, 14 south entry, left entry main rise 150 feet from entry.
Method of sampling .....Regular
Gross weight, lbs. 28
Net weight, grams 1191.7
Date of sampling 6-17-18
Date of laboratory sampling 6-22-18
Date of analysis 6-24-18
Collector .....W. B. Plank

Air-dry Loss, 2.8		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	4.12	6.78	.....	.....
	Volatile matter	34.38	33.43	35.86	41.88
	Fixed carbon	47.72	46.39	49.77	58.12
	Ash	13.70	13.40	14.37	.....
		100.00	100.00	100.00	100.00
Sulphur		1.24	1.21	1.30	1.52
Calorific Value	Calories	6693	6508	6981	8152
	B. T. U.	12047	11704	12566	14674

Laboratory number, U. S. Bureau of Mines 30,748
Operator ..... West Kentucky Coal Co.
Mine ..... No. 7
State ..... Kentucky
County ..... Webster
Bed ..... No. 14
Town ..... 1 mile west of Clay on I. C. and L. N. R. R.
Location in mine ..... Face 24 room, left entry, east dip entry 250 feet from entry.
Method of sampling ..... Regular
Gross weight, lbs. 26
Net weight, grams 1116.4
Date of sampling 6-17-18
Date of laboratory sampling 6-22-18
Date of analysis 6-25-18
Collector ..... W. B. Plank

Air-dry Loss, 1.3		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.33	4.61	.....	.....
	Volatile matter	37.04	36.55	38.32	41.44
	Fixed carbon	52.36	51.67	54.16	58.56
	Ash	7.27	7.17	7.52	.....
		100.00	100.00	100.00	100.00
Sulphur		1.09	1.08	1.13	1.22
Calorific Value	Calories	7328	7231	7580	8196
	B. T. U.	13190	13016	13644	14753

Laboratory number, U. S. Bureau of Mines.....30,749
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town .....Clay on I. C. and L. N. R. R.
Location in mine....Face 10 room, 2nd south entry, 7th right east dip entry, 100 feet from entry.
Method of sampling .....Regular
Gross weight, lbs. 26
Net weight, grams 1158.4
Date of sampling 6-17-18
Date of laboratory sampling 6-22-18
Date of analysis 6-25-18
Collector .....W. B. Plank

Air-dry Loss, 1.3		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.20	4.49	.....	.....
	Volatile matter	35.80	35.32	36.98	41.41
	Fixed carbon	50.64	49.97	52.32	58.59
	Ash	10.36	10.22	10.70	.....
		100.00	100.00	100.00	100.00
Sulphur		1.05	1.04	1.09	1.22
Calorific Value	Calories	7061	6967	7294	8168
	B. T. U.	12710	12571	13129	14702

Laboratory number, U. S. Bureau of Mines.....30,750
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town .....1 mile west of Clay on I. C. and L. N. R. R.
Location in mine.....Face 3rd south entry, 3rd left entry, main rise 270 feet from 3rd left entry.
Method of sampling .....Regular
Gross weight, lbs. 32
Net weight, grams 1137.6
Date of sampling 6-17-18
Date of laboratory sampling 6-22-18
Date of analysis 6-26-18
Collector .....W. B. Plank

Air-dry Loss, 1.9		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	4.13	5.99		
	Volatile matter	35.75	35.06	37.29	40.11
	Fixed carbon	53.39	52.35	55.69	59.89
	Ash	6.73	6.60	7.02	
		100.00	100.00	100.00	100.00
Sulphur		1.10	1.08	1.15	1.24
Calorific Value	Calories	7309	7167	7624	8200
	B. T. U.	13156	12901	13723	14760

Laboratory number, U. S. Bureau of Mines.....30,751
Operator .....West Kentucky Coal Co.
Mine .....No. 7
State .....Kentucky
County .....Webster
Bed .....No. 14
Town .....1 mile west of Clay on I. C. and L. & N. R. R.
Location in mine .....Comp. of Lab. Nos. 30,747, 48, 49 and 50
Date of analysis 6-28-18
Collector .....W. B. Plank

Air-dry Loss, 1.3		Coal Air Dried	Coal As Received	Coal Moisture Free	Coal Moisture and Ash Free
Proximate Analysis	Moisture	3.58	5.35	.....	.....
	Volatile matter	35.57	34.92	36.89	40.93
	Fixed carbon	51.34	50.39	53.24	59.07
	Ash	9.51	9.34	9.87	.....
		100.00	100.00	100.00	100.00
Ultimate Analysis	Hydrogen	5.01	5.12	4.78	5.31
	Carbon	71.71	70.39	74.37	82.52
	Nitrogen	1.58	1.55	1.64	1.82
	Oxygen	11.12	12.55	8.22	9.12
	Sulphur	1.07	1.05	1.11	1.23
	Ash	9.51	9.34	9.87	.....
		100.00	100.00	100.00	100.00
Calorific Value	Calories	7075	6945	7337	8140
	B. T. U.	12735	12501	13207	14652

SECTIONS OF COAL BED WHERE MINE SAMPLES WERE TAKEN BY L. C. GLENN.

G-3474. Teague mine. Head of main entry.

Black shale	3′
Fossiliferous calcareous shale	4″
Coal, solid	4′
Hard clay floor.	

G-3476. Vaughn and Nesbit. Head of main entry.

Dark shale roof	3′ 6″
Calcareous shale with marine fossils	3″
Coal	3′ 2″
Sulphur band	1″
Coal	10″
Hard clay floor.	

3559. E. Curry. Head main entry.

Black shale roof.	
Coal, solid	4′ 6″

G-3478. McGraw. Head of main entry.

Black shale roof	3′ 6″
Coal	4′ 6″

G-3477. Wallace.

Black shale, with niggerheads	3′
Coal	4′ 7″

3556. Fairmont. Head first left entry.

Black shale	2′
Coal	4′ 6″

3555. Galbraith.

Black shale roof	3′
Coal	4′ 8″

3560. Blackwell (Clifty Consolidated.) Room 7, first south entry.

Black shale roof.	
Coal	4′ 9″

3554. Diamond No. 1. Head of third east entry.

Black shale roof.	
Coal	4′ 9″

G-3483. Ruckman No. 2. End of main north entry.

Black shale roof.	
Coal	4′ 11″

G-3482. Leeper. Room 9, first right entry.

Black shale	3′ 6″
Coal	4′ 10″
Hard clay floor.	

G-3481. H. D. Hill. Head of main entry.

Black shale roof.	
Coal	5′ 1″

G-3480. S. K. Luton, third room on dip entry.
Black shale roof.
Coal ..... 5′

G-3489. Monroe, or Brent-Hart. Head of main entry.
Black shale.
Coal ..... 4′ 11″

G-3488. Wanless. Head main entry.
Black shale roof.
Coal ..... 4′ 9″

G-3487. Providence Mining Co., No. 1. Head of main entry.
Black shale roof.
Coal ..... 4′ 9½″

G-3485. Providence Mining Co., No. 2. Room 18, first east cross entry off main south.
Black shale roof.
Coal ..... 4′ 9″
Hard clay floor.

G-3484. Providence Mining Co. Room 1, first south entry off main east.
Black shale roof.
Coal ..... 4′ 9″

G-3490. J. F. Woods. First right room off main entry.
Black shale roof.
Coal ..... 4′ 4″

3492. Sebree Coal and Mining Co. Room 52, fourth north entry.
Black shale roof.
Coal ..... 4′ 3″

3494. West Kentucky Coal Co., Wheatcroft No. 3. Head of main entry.

1.	Limestone.	
2.	Hard dark slate	2′ 6″
3.	Coal	11½″
4.	Sulphur, knife edge to	½″
5.	Coal	2′ 7½″
6.	Blue band	2½″
7.	Coal	1′ 11½″
8.	Hard underclay.	

Sampled 3, 5, 7.

3558. West Kentucky Coal Co., Wheatcroft No. 4. Room 2, third east entry.

1.	Limestone	6′ to 8′	
2.	Soft clay, gob		0″ to 15″
3.	Coal		7″
4.	Sulphur, knife edge to		½″
5.	Coal	2′ 2″	
6.	Sulphur, knife edge.		
7.	Coal		8″
8.	Blue band		2″

9.	Coal	10″
10.	Blue band	0″ to ½″
11.	Coal	2½″
12.	Blue band	½″
13.	Coal	5½″

Underclay.

Sampled 3, 5, 7, 9, 11, 13.

3495. Lever. Head of main.

1.	Limestone	8′
2.	Gob	0″ to 18″
3.	Coal	1′ 1″
4.	Sulphur	½″
5.	Coal	2′ 5″
6.	Blue band	2″
7.	Coal	1′ 10½″

Sampled 3, 5, 7.

G-3479. Gaines. Head of main.

1.	Limestone.	
2.	Gob	8″
3.	Coal	9″
4.	Sulphur, knife edge.	
5.	Coal	3′ ½″
6.	Blue band	2″
7.	Coal	1′ 11½″

G-3486. Webster County Coal Co., or Economy Coal Co. Room 15, off first west entry.

1.	Limestone.	
2.	Gob	1′ 3″
3.	Coal	1′ 4″
4.	Sulphur	½″
5.	Coal	2′ 7″
6.	Blue band	1½″
7.	Coal	2′

Sampled 3, 5, 7.

G-3475. St. Bernard Mining Co., Shamrock. Head of fifth east entry off main north.

1.	Limestone.	
2.	Gob	6″
3.	Coal	1′ 1″
4.	Sulphur	½″
5.	Coal	2′ 9½″
6.	Blue band	2″
7.	Coal	1′ 11″

Sampled 3, 5, 7.

G-3491. Marks. Head of main entry.

Black shale	2′
Coal	3′ 9″

3557. West Kentucky Coal Co., Baker, or Mine 5. Room 38, main rise entry.

1. Coal, left as roof	12″-15″
2. Coal, sampled	4′ 6″

3493. West Kentucky Coal Co., Mine 7. On main entry near foot of shaft.

Soft clay	2′ 6″
Coal, solid	7′ 6″

APPENDIX

KEY TO LOCALITY REFERENCES IN TEXT AND ON MAP

1. Limestone northwest of Steamport Ferry.
2. Chert near Ashley's quarry, a mile southwest of Steamport Ferry.
3. Chert southwest of Sebree.
4-7. Fucoidal mudstone or sandstone, southwest of Sebree.
8. Fucoidal sandstone, three-quarters of a mile south of Bald Knob.
9. Bore hole to coal 6, Montezuma, location approximate only.
10. Vaughn and Nesbit's mine, coal No. 6.
11. Curry's mine, coal No. 6.
12. Teague's mine, coal No. 6.
13. Coal No. 7, Smith place.
14. Coal No. 8a, west of Ruff.
15. Coal No. 6, probably; southwest of Sebree.
16. Bore hole, Providence oil well.
17. Korf shaft, east of Clay.
18. D. B. Baker bore, east of Clay.
19. Prow Mine, coal No. 12, northeast of Ortiz.
20. Providence limestone, just east of Frank Saunders, in shear zone of Rough creek fault.
21. Madisonville limestone, 1¼ miles northeast of Breton.
22. Limestone and bony coal, in road four miles north of Clay.
23. Limestone and coal, in woods four miles north of Clay.
24. Coal at W. S. Shelton's, southeast of Tilden.
25. Coal at Green Chandler's, southeast of Tilden.
26. Coal on point of hill, 2½ miles south of Wanamaker.
27. Coal at John Brooks', one mile north of Mt. Pleasant.
28. Coal at W. M. Henry's, one mile northwest of Belcourt.
29. Coal, bank of Deer creek, 1½ miles south of Catesville.
30. Limestone and sinkholes, in Mt. Gilead shales, 2 miles southwest of Mt. Gilead school.
31. Birdeye cannel coal, 2 miles northwest of Luzon.
32. Pleistocene gravel, at bridge over Deer creek, 2½ miles south of Sebree.
33. Pleistocene gravel, Green river flats, 3 miles northeast of Onton.
34. Air shaft, mine 6, West Kentucky Coal Co., Wheatcroft.
35. Leeper Coal Co., mine, south of Providence.
36. Luten mine, coal 9, south of Providence.
37. H. D. Hill mine, coal 9, south of Providence.
38. Ruckman No. 3 mine, coal 9, Providence.
39. Providence No. 3 mine, coal 9, Providence.
40. Providence No. 1 mine, coal 9, Providence.

41. Brent-Hart mine, coal 9, Providence.
42. Diamond Coal Co., mine 1, coal 9.
43. Wood mine, coal 9, Marksville.
44. Sebree Coal Co., shaft, coal 9, Sebree.
45. A. J. Johnson mine, coal 9, Fairmont.
46. Galbraith mine, coal 9, Oyama.
47. McGraw mine, coal 9, west of Wheatcroft.
48. Fairmont mine, coal 9, Fairmont.
49. E. Curry mine, coal 9, west of Wheatcroft.
50. West Kentucky Coal Co., mine 4, coal 11, Wheatcroft.
51. West Kentucky Coal Co., mine 3, coal 11, Wheatcroft.
52. J. E. Lever mine, coal 11, 3 miles northwest of Providence.
53. Wynn mine, coal 11, Providence.
54. Gaines Coal Co. mine, coal 11, southeast of Providence.
55. St. Bernard Mining Co., Shamrock mine, coal 11, Providence.
56. Webster County Coal Co., mine, coal 11, Providence.
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58. Providence limestone and coal 12, near Frank Saunders', west of Sebree.
59. West Kentucky Coal Co., bore 2, northwest of Clay.
60. West Kentucky Coal Co., bore 8, northwest of Clay.
61. West Kentucky Coal Co., bore 13, northeast of Clay.
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63. West Kentucky Coal Co., bore 15, northwest of Clay.
64. West Kentucky Coal Co., bore 20, north of Clay.
65. West Kentucky Coal Co, bore 21, north of Clay.
66. West Kentucky Coal Co., Baker, or No. 5 mine, on coal 14, or Baker coal.
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68. Bore hole at Sebree, east of railroad.
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70. Blackwell bore No. 1, Edmonston farm, south of Clay.
71. Blackwell bore No. 2, Aldridge property, Clay.
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73. Blackwell bore No. 4, Edmonston farm, south of Clay.
74. Blackwell bore No. 5, Hicks farm, south of Clay.
75. Old Blackwell shaft, Clay.
76. Baker bore No. 1, east of Wheatcroft.
77. Baker bore No. 2, Frier farm, west of Clay.
78. Baker bore No. 3, Henry farm, north of Fairmont.
79. Baker bore No. 4, Sidney Hill farm, near Baker mine, west of Clay.
80. Fairmont bore hole, Fairmont.
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82. Webster County Coal Co. bore, northeast of Providence.
83. Justice bore No. 1, east of Providence.
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86. Sights' well, north of Tilden.
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89. Providence Coal Co., mine No. 2, coal 9, Providence.
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92. Wm. Silvey mine, coal 6, near Gould's.
93. Ruckman No. 1, coal 9, Providence.
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